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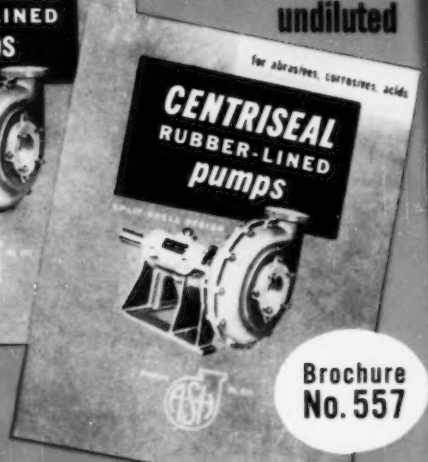

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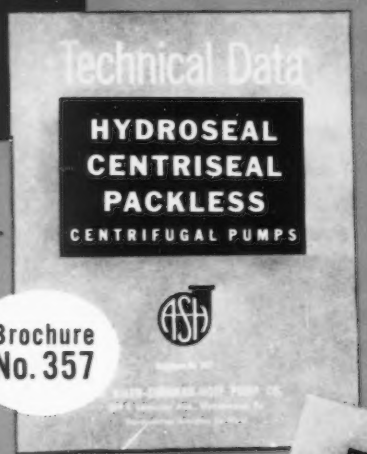

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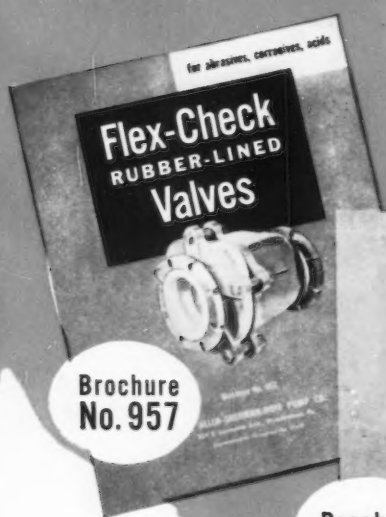

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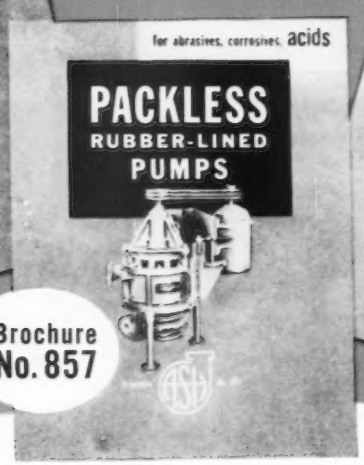

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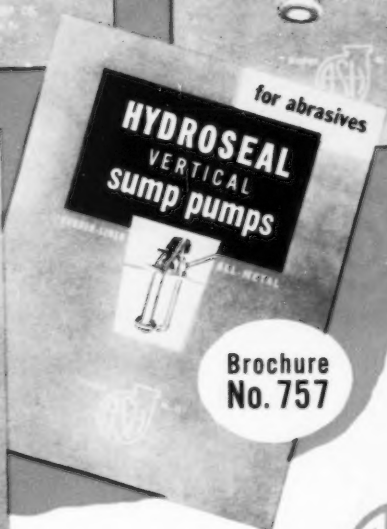

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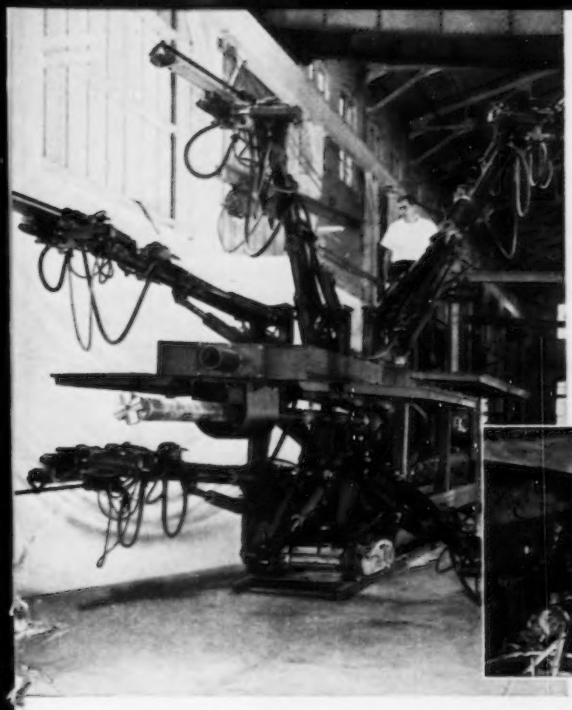

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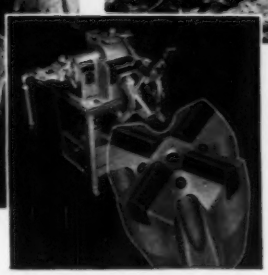

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ENGINEERING AND MINING JOURNAL MINING GUIDEBOOK

MID-JUNE 1958 Volume 159, No. 6a

Recovering the World's Minerals
Mineral output of the world with specific tonnages by area and country are listed in four pages of tables supplied by USBM 21

How Ore Deposits are Classified
A suggested method of classifying ore deposits for mining men which substitutes the prospectors' terminology for the more theoretical terms of thermal classification 26

The Mine Office—Tools and Techniques
The editors have selected, from current literature and company announcements, machines for the modern mine office 29

Mine Power—Conductors
Construction of mine power cables—conductors, insulation materials, sheathing, ground wires, covering. How to select the right cable for the job 36

Mine Power—Safety Circuits
How to design mine circuits to prevent ground-fault damage to equipment and injury to workmen 53

Scales in Mining
E&MJ surveyed a number of major mining operations, asking "What scales are used, where?" The results indicate use, type and application 62

Processing Flowsheets Across the Board
What is your processing problem? Here are 32 pages of selected flowsheets from Au to Zn 65

Selecting Loading and Hauling Units
Describes a systematic approach to selecting muck-handling equipment of all types. Some loading units are pictured and the specification table gives data on many actual units 97

Boning Up on Blasting
Brief explanation of the reflection theory of rock breakage by blasting with some recent formulas for computing burden and quantity of explosives required, a simple cost analysis and some case histories 102

Percussion Drill Steel Facts of Life
Gives the mechanics of failure and recommended means of combatting various failures and presents data on composition of current drill steels 110

Good Filing Keeps Knowledge at Your Fingertips
Tells you how *E&MJ* files technical material for ready reference 114

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Your 1958 Guidebook

WHAT IT IS. This is the fifth annual *E&MJ* Mining Guidebook and Buying Directory. As in the past, it is designed to work with the preceding issues in giving you the information you have indicated you need to better facilitate the job of planning exploration, mining, milling and smelting projects.

The returns on a questionnaire which the editors mailed to mining companies and manufacturers requesting information for this Guidebook, have provided the latest data on techniques, equipment and recommended practices. This Guidebook presents equipment panoramas, charts and tables for present and future reference.

HOW TO USE IT. If you're planning a new project or revamping an old one, you can do better with the help of the five Guidebooks and Buying Directories which are indexed on pages 6 and 7. The Guidebooks are designed to complement and supplement each other. A new feature in this issue is the Index which puts all the Guidebooks information in a simple and accessible form. And, by using the Guidebook section in conjunction with the Buying Directory and the advertisements appearing in the issue, you can find out all you need to know before purchasing.

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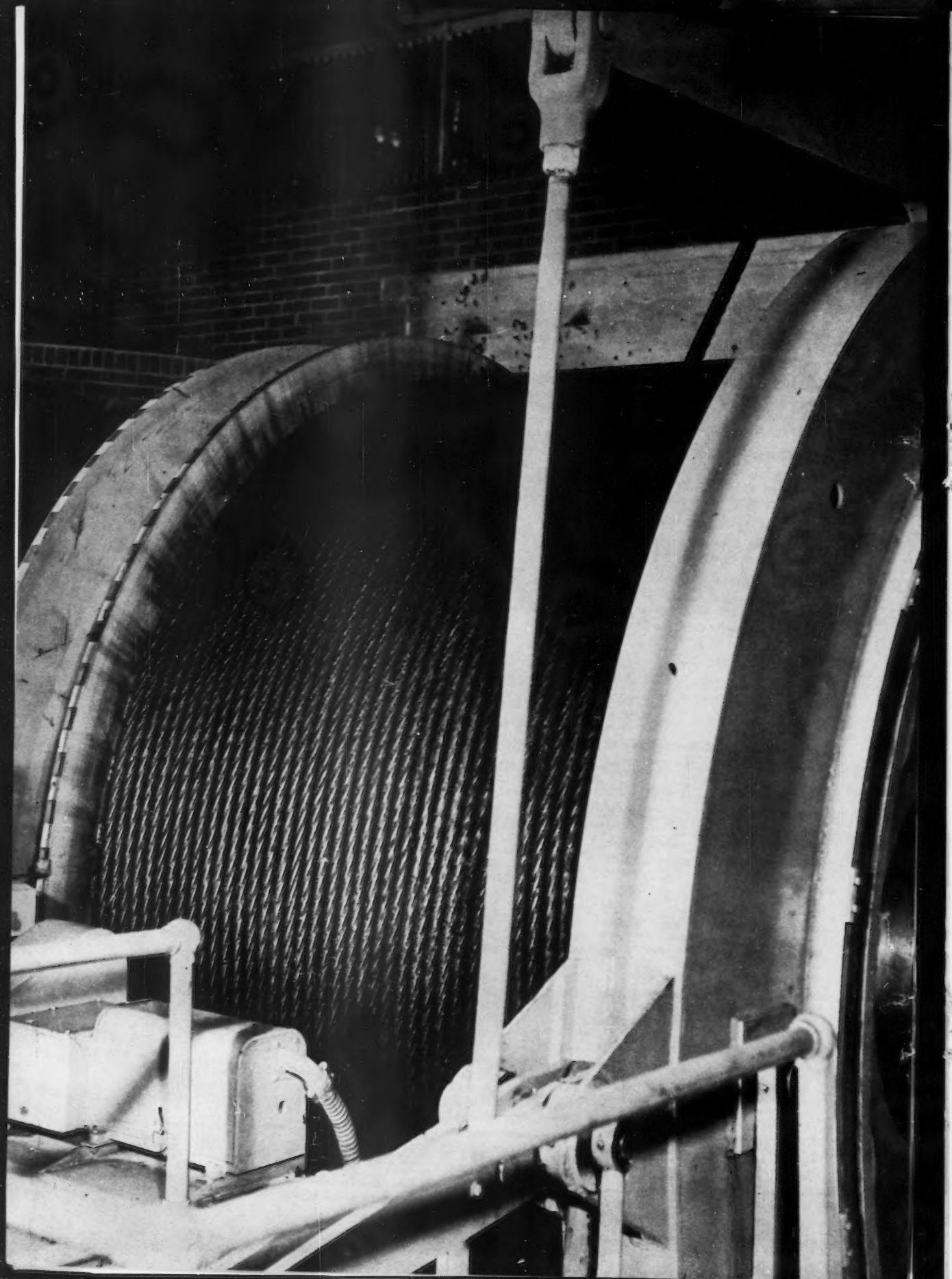

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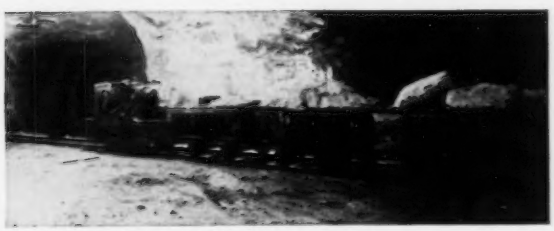

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E&MJ's ANNUAL MINING GUIDEBOOKS are designed to complement and supplement each other. This index will help you find subjects covered in the five issues that have been published so far—May 1954, Mid-March 1955, Mid-June 1956, Mid-June 1957 and this, Mid-June 1958.

This cumulative index has been extracted from our indices which are published annually in the December issue of *E&MJ*. The Annual Index also includes subject cross

Cumulative Index of E&MJ Guidebooks 1954-1958

Agglomerating also see: Pyrolytic Processing (sintering)
- At Reserve it's a downdraft continuous grate furnace....1957: 112
- Balling disk....1957: 117
- Balling drum....1957: 116
- Erie does pelletizing in shaft furnaces....1957: 114
- Growing art of agglomeration....1957: 112
- Lurgi process combines up-and-down-draft sintering....1957: 112
- Marquette uses an updraft-downdraft sintering machine....1957: 114
- Numerous ways of forming pellets....1957: 116

Aluminum
- Pit-to-port facilities in Jamaica....1954: G 144

Beneficiating, Mineral also see: Processing
- At Reserve it's a downdraft continuous grate furnace....1957: 112
- Balling disk....1957: 117
- Balling drum....1957: 116
- Column ion exchange at Bicroft Uranium Mines Ltd. (flowsheet)....1958: 92
- Column ion exchange for uranium at Dawn Mining Co. (flowsheet)....1958: 82
- Crushers — types, sizes and capacities (tables)....1957: 92
- Erie does pelletizing in shaft furnaces 1957: 114
- Flotation of chalcopyrite at Pima Mining Co. (flowsheet)....1958: 68
- Flotation of hematite at Jones & Laughlin's Hill Annex (flowsheet)....1958: 69
- Flotation of mercury at Arentz-Comstock (flowsheet)....1958: 75
- Flotation of Michigan jasper at Marquette Iron Mining Co. (flowsheet)....1958: 70
- Flotation of oxidized lead-zinc at Gorno (flowsheet)....1958: 96
- Flotation reagents (table)....1955: 66
- Flotation reagents (tables)....1956: 111
- Facts about filter fabric....1957: 99
- For better metallurgy—a checklist of solids-gas contacting equipment....1957: 106
- Gravity concentration at Metal & Thermit's rutile-ilmenite concentrator (flowsheet) 1958: 77
- Gravity and flotation concentration of cobalt-silver at Cobalt (flowsheet)....1958: 81
- Growing art of agglomeration....1957: 112
- Heavy media separation at South River manganese (flowsheet)....1958: 91
- How belt concentrators recover phosphate at Coronet (flowsheet)....1958: 76
- How cyclones perform—case histories from the mining industry....1957: 90
- How to get the most out of a wet cyclone 1957: 86
- How to keep solids flowing in bins and hoppers A. W. Jenike (charts)....1955: 83
- How to predict rod mill power requirements Nathaniel Arbiter (charts & table)....1955: 63
- If you are planning uranium extraction, take a look at today's flowsheets W. L. Lennemann (tables)....1956: 122
- Lurgi process combines up-and-down-draft sintering....1957: 112
- Marquette uses an updraft-downdraft sintering machine....1957: 114
- Nickel Processing Corp. Nicaro plant 1957: 118
- Numerous ways of forming pellets....1957: 116
- Resin-in-pulp at Uranium Reduction Co. (flowsheet)....1958: 78
- Separation characteristics of minerals (table)....1957: 85
- Size data on some modern flotation machines (tables)....1957: 82
- Solvent extraction for uranium at Vitro Uranium Co. (flowsheet)....1958: 87
- Swedish hematite pilot plant flotation flowsheet....1958: 71
- These mill design features are paying off C. K. Bain....1955: 78
- Uranium extraction flowsheets....1957: 122
- Uranium metallurgy highlights (table) 1955: 95
- Using acetone to extract uranium (patent) 1958: 74
- Vacuum and pressure filters for concentrate and process water (tables)....1957: 96
- What goes into modern mill design C. K. Bain....1955: 76

Bismuth
- Refining bismuth at Cerro de Pasco (flowsheet)....1958: 93

Blasting
- Boning up on blasting: Reflection Theory 1958: 102
- Case histories of surface drilling and blasting (table)....1958: 106
- Chart your breaking cost to get the full picture....1958: 105
- Drilling and blasting data for various types of metal and nonmetallic open pit mines (table)....1955: 50
- Explosives and their applications (tables) 1957: 68
- Explosives and their applications (tables) 1956: 90
- Formulae can help plan efficient blasts 1958: 104
- Open-pit mining (tables)....1954: G 7
- Secondary blasting costs (tables)....1954: G 18
- Stemming for blastholes....1954: G 18

Cadmium
- Electrolytic cadmium at Anaconda Co. (flowsheet)....1958: 84

Chromium
- Electrolytic chromium at Key Metals Corp. (patent)....1958: 84

Cobalt
- Calera Mining Co. (flowsheet)....1957: 120
- Chemical metallurgy solves low-grade, complex ore problems H. L. Talbot....1955: 52
- Gravity and flotation concentration of cobalt-silver at Cobalt (flowsheet)....1958: 81
- Producing electrolytic cobalt at Calera Mining Co. (flowsheet)....1958: 72
- Smelting cobalt-silver ores at Deloro (flowsheet)....1958: 89
- Solution processing of cobalt at Sherritt Gordon Mines Ltd. (flowsheet)....1958: 71
- Swedish hematite pilot plant flotation flowsheet....1958: 71

Comminuting
- Crushers — types, sizes and capacities (tables)....1957: 92
- Gyratory crushers (tables)....1957: 94
- How to predict rod mill power requirements Nathaniel Arbiter (charts & table)....1955: 63
- Roll crushers (tables)....1957: 95

Communications & Automatic Controls
- Scales in mining: a survey....1958: 62
- Two-way radios speed open-pit work....1954: G 136

Concentrating & Solids Separation does not include: scrubbing and washing (see Agitating); Pyrolytic Processing; Solution Processing; Comminuting; Agglomerating; Sizing
- Flotation of chalcopyrite at Pima Mining Co. (flowsheet)....1958: 68
- Flotation of hematite at Jones & Laughlin's Hill Annex (flowsheet)....1958: 69
- Flotation of mercury at Arentz-Comstock (flowsheet)....1958: 75
- Flotation of Michigan jasper at Marquette Iron Mining Co. (flowsheet)....1958: 70
- Flotation of oxidized lead-zinc at Gorno (flowsheet)....1958: 96
- Flotation reagents (table)....1955: 66
- Flotation reagents (tables)....1956: 111
- Gravity concentration at Metal & Thermit's rutile-ilmenite concentrator (flowsheet) 1958: 77
- Gravity and flotation concentration of cobalt-silver at Cobalt (flowsheet)....1958: 81
- Heavy media separation at South River manganese (flowsheet)....1958: 91
- How belt concentrators recover phosphate at Coronet (flowsheet)....1958: 76
- Separating solids from solids (chart)....1956: 103
- Separation characteristics of minerals (table) 1957: 85
- Size data on some modern flotation machines (tables)....1957: 82
- Swedish hematite pilot plant flotation flowsheet....1958: 71

Construction
- What goes into modern mill design C. K. Bain....1955: 76

Copper
- Boliden smelter flowsheets....1958: 86
- Chemical metallurgy solves low-grade complex ore problems H. L. Talbot....1955: 52
- Flotation of chalcopyrite at Pima Mining Co. (flowsheet)....1958: 68
- How fluidization can serve the mineral industries T. B. Counselman....1955: 70
- Role of geophysical methods in modern exploration programs Dr. A. A. Brant (charts)....1955: 25

Development, Mine also see: Engineering (planning layout); Valuation (ore reserve calculation); Economics (financing); Exploration
- How to plan and develop an open-pit mine George Huseman....1955: 45
- Mechanical planned cycling speeds Carlsbad shaft job J. A. Lilly....1956: 96
- New ways for faster stripping....1954: G 36
- Planning the pit (map)....1954: G 3
- Shaft mucking machines can fit most conditions....1957: 80
- Shaft sinking methods go modern....1956: 94
- Trends in modern mine hoisting....1957: 38

Dolomite
- How fluidization can serve the mineral industries T. B. Counselman....1955: 70

Drilling, Boring & Cutting Rock & Earth also see: Loading (dredging & hydraulicking)
- Case histories of surface drilling and blasting (table)....1958: 106
- Cerro de Pasco Drillers' Manual defines exploration procedures H. A. Kursell 1955: 19
- Checklist of drill steel (table)....1958: 113
- Current trends in pit practice....1954: G 8
- Drill rounds (charts)....1954: G 20
- Drillability table for rock....1954: G 18
- Drilling and blasting data for various types of metal and nonmetallic open pit mines (table)....1955: 50
- Exploration drilling....1957: 19
- For deeper holes, diamond drill designs stress power, mobility, durability, economy Vernon Read (tables)....1956: 22
- From bit to shank, many tools make holes 1956: 85
- Guides to proper selection of modern underground mine equipment Roger Pierce 1955: 33
- Heavy exploration drills (over 2,000 ft.) (table)....1957: 24
- Jumbos speed mine drilling....1956: 78
- Light reconnaissance drills Vernon Read (tables)....1956: 21
- List of open pit blasthole drills and specifications aids selection (table)....1957: 72
- Mechanical ways to mine medium and soft ground....1956: 84
- Medium exploration drills (300 to 2,000 ft.) (table)....1957: 22
- Mining's aim for greater productivity starts with the rock bit....1957: 32
- New open-pit drilling methods....1956: 60
- Open-pit mining (tables)....1954: G 7
- Panorama of rock bits....1957: 35
- Percussion drill steel facts of life....1958: 110
- Portable light reconnaissance drills (to 300 ft.) (table)....1957: 20
- Portable rock drills (table)....1957: 21
- Progress in rock drill design....1956: 81
- Selecting the right diamond bit Vernon Read (table)....1956: 26
- Six ways to beat overburden problems 1957: 24
- Today's core barrels meet tougher trials than ever Vernon Read....1956: 28
- Wedging—a useful tool for deep drilling 1957: 25

Economics, Marketing & Financing also see: individual commodities and countries; Legislation
- Mineral production of the world (table) 1958: 22
- Prospecting and developing ore deposits in bedded formations G. M. Fowler & others (map & tables)....1955: 6

Engineering, Research & Science also see: Exploration; Geology; Geophysics; Geochemistry; Valuation; Personnel (education & training, selection)
- Good filing keeps knowledge at your fingertips....1958: 114
- The Mine Office: tools and techniques 1958: 29

Exploration
- Airborne electromagnetic method speeds prospecting (charts)....1957: 27
- Airborne magnetometer aids geologic mapping....1957: 28
- Checklist of drill steel (table)....1958: 113
- Classification of ore deposits C. J. Sullivan (table)....1958: 26

# of E&MJ Guidebooks Contains

references to help the user find subjects more readily but these have been omitted from this Guidebook Index. Our complete indexing list, including cross references, is given on page 116. A functional grouping of technical subjects is in the article "Good Filing Keeps Knowledge At Your Fingertips" on page 114. Country, company and author references, a normal part of our Annual Index, have also been omitted.

Exploration drilling ... 1957: 19
Cerro de Pasco Drillers' Manual defines exploration procedures H. A. Kursell 1955: 19
For deeper holes, diamond drill designs stress power, mobility, durability, economy Vernon Read (tables) ... 1956: 22
Get the best values from drill'hole samples Vernon Read ... 1957: 19
Heavy exploration drills (over 2,000 ft.) (table) ... 1957: 24
How geophysical techniques save exploration dollars Vernon Read (table) ... 1956: 32
Light reconnaissance drills Vernon Read (tables) ... 1956: 21
Light reconnaissance drills (to 300 ft.) (table) ... 1957: 20
Medium exploration drills (300 to 2,000 ft.) (table) ... 1957: 22
The Mine Office: tools and techniques 1958: 29
Planning the exploration program Vernon Read ... 1956: 19
Planning the pit (map) ... 1954: G 3
Portable rock drills (table) ... 1957: 21
Prospecting and developing ore deposits in bedded formations G. M. Fowler & others (map & tables) ... 1955: 6
Radioactivity detection ... 1957: 28
Role of geophysical methods in modern exploration programs Dr. A. A. Brant (charts) ... 1955: 25
Selecting the right diamond bit Vernon Read (table) ... 1956: 26
Six ways to beat overburden problems 1957 24
Summing up the U. S. airborne exploration effort ... 1957: 30
These characteristics aid mineral detection (table) ... 1957: 26
Today's core barrels meet tougher trials than ever Vernon Read ... 1956: 28
Two examples of the role of airborne exploration ... 1957: 29
Wedging—a useful tool for deep drilling ... 1957: 25

Ferroalloys
Strategic-Udy processes for iron and ferroalloys ... 1958: 85

Geochemistry & Mineralogy
The Mine Office: tools and techniques 1958: 29

Geology, General & Structural also see: Engineering (surveying)
Butte combines gravity and slushing 1957: 48
Classification of ore deposits C. J. Sullivan (table) ... 1958: 26
Climax scrapes below unusual undercut ... 1957: 44
How to plan and develop an open-pit mine George Huseman ... 1955: 45
Miami uses slusher and belt-conveyor scheme ... 1957: 46
The Mine Office: tools and techniques 1958: 29
Prospecting and developing ore deposits in bedded formations G. M. Fowler & others (map & tables) ... 1955: 6

Geophysics
Airborne electromagnetic method speeds prospecting (charts) ... 1957: 27
Airborne magnetometer aids geologic mapping ... 1957: 28
How geophysical techniques save exploration dollars Vernon Read (table) ... 1956: 32
The Mine Office: tools and techniques 1958: 29
Role of geophysical methods in modern exploration programs Dr. A. A. Brant (charts) ... 1955: 25
Summing up the U. S. airborne exploration effort ... 1957: 30
Two examples of the role of airborne exploration ... 1957: 29

Gold
Cyanide for gold at Belleterre Quebec (flowsheet) ... 1958: 80
How fluidization can serve the mineral industries T. B. Counselman ... 1955: 70

Ground Control & Support
Butte combines gravity and slushing 1957: 48
Climax scrapes below unusual undercut ... 1957: 44
Concrete has proven itself ... 1957: 53
Miami uses slusher and belt-conveyor scheme ... 1957: 46
The Mine Office: tools and techniques 1958: 29
Plastic, resin and glass are newcomers 1957: 53
Rock is important for pillars and fill 1957: 53
Rockbolts are versatile ... 1957: 51
Steel props deserve a look ... 1957: 52
Steel yieldable sets and liner plate combat special conditions ... 1957: 52
Timber is still major material ... 1957: 53
What to use for ground support ... 1957: 50

Iron
Flotation of hematite at Jones & Laughlin's Hill Annex (flowsheet) ... 1958: 69
Flotation of Michigan jasper at Marquette Iron Mining Co. (flowsheet) ... 1958: 70
Growing art of agglomeration ... 1957: 112
How fluidization can serve the mineral industries T. B. Counselman ... 1955: 70
How to plan and develop an open-pit mine George Huseman ... 1955: 45
Pit-to-port facilities in Venezuela ... 1954: G 138
Strategic-Udy processes for iron and ferroalloys ... 1958: 85
Swedish hematite pilot plant flotation flowsheet ... 1958: 71

Lead
Boliden smelter flowsheets ... 1958: 86
Cerro de Pasco Drillers' Manual defines exploration procedures H. A. Kursell 1955: 19
Flotation of oxidized lead-zinc at Gorno (flowsheet) ... 1958: 96

Limestone
How fluidization can serve the mineral industries T. B. Counselman ... 1955: 70

Lithium
Kiln process for lithium at Lithium Corp. of America (flowsheet) ... 1958: 90

Loading & Handling Mine Muck also see: Transporting; Drilling (continuous mining); Materials Handling (other than mine muck)
Checklist of loaders (table) ... 1958: 100
Draglines—useful capacity and performance data for medium and large (table & chart) ... 1954: G 50
Guides to proper selection of modern underground mine equipment Roger Pierce 1955: 33
Handling rock from face to pocket ... 1956: 70
How to systematize selection of muck handling equipment ... 1957: 74
Muck handling specification tables ... 1957: 76
Panorama of earthmoving equipment (charts & tables) ... 1956: 39
Selecting loading and hauling units ... 1958: 97
Shaft mucking machines can fit most conditions ... 1957: 80
Shovels—useful capacity and performance data for medium and large (chart & table) 1954: G 49

Maintenance & Shops also see: Power
Conveyors—three tips to reduce maintenance (charts) ... 1954: G 94
Longer life for trucks ... 1954: G 88
The Mine Office: tools and techniques 1958: 29
Planned maintenance pays (charts) ... 1954: G 82
Rail haulage—how to keep it moving ... 1954: G 113
Tires—how to keep them rolling longer ... 1954: G 97

Manganese
Heavy media separation at South River manganese (flowsheet) ... 1958: 91

Materials Handling, Process, Mill & Plant for other than process see: Materials Handling, General; Loading, Mine; Transporting, Mine; Water Control, Mine
Modern pumps, their design, applications and selection ... 1957: 63
Scales in mining: a survey ... 1958: 62
What to expect of modern pumps W. B. Stephenson (charts & tables) ... 1955: 86

Materials Handling, Storing & Transporting, General also see: Loading & Handling Mine Muck; Transporting & Hoisting, Mine; Water Control, Mine; Materials Handling, Process; Office & Supply Service
Bauxite pit-to-port facilities in Jamaica 1954: G 144
Ilmenite pit-to-smelter facilities in Canada 1954: G 140
Iron ore pit-to-port facilities in Venezuela 1954: G 138
Modern pumps, their design, applications and selection (tables) ... 1957: 63
Scales in mining: a survey ... 1958: 62
What to expect of modern pumps W. B. Stephenson (charts & tables) ... 1955: 86

Mercury
Flotation of mercury at Arentz-Comstock (flowsheet) ... 1958: 75

Metallurgy, Extractive also see: Processing; Beneficiating
Chemical flowsheet, Calera Mining Co. 1957: 120
Chemical metallurgy solves low-grade, complex ore problems H. L. Talbot ... 1955: 52
Chemical techniques unlock laterites 1955: 54
Chlorination of mixed sulphides at Mitterberg Mining Co. ... 1958: 74
Cyanide for gold at Belleterre Quebec (flowsheet) ... 1958: 80
Electrolytic cadmium at Anaconda Co. (flowsheet) ... 1958: 84
Electrolytic chromium at Key Metals Corp. (patent) ... 1958: 84
Flowsheet, Sherritt Gordon Mines, Ltd. 1957: 121
For better metallurgy—a checklist of solids-gas contacting equipment ... 1957: 106
How Inco produces electrolytic nickel from nickel matte (flowsheet) ... 1958: 95
Information needed in planning a solids-gas contacting operation ... 1957: 110
International Nickel Co. smelter now and then ... 1958: 94
Nickel Processing Corp. Nicaro plant 1957: 118
Producing electrolytic cobalt at Calera Mining Co. (flowsheet) ... 1958: 72
Refining bismuth at Cerro de Pasco (flowsheet) ... 1958: 93
Removing magnesia from electrolytic zinc circuit at Bunker Hill Co. (flowsheet) 1958: 88
Rise in chemical metallurgy ... 1957: 118
Smelting cobalt-silver ores at Deloro (flowsheet) ... 1958: 89
Solution processing of cobalt at Sherritt Gordon Mines Ltd. (flowsheet) ... 1958: 71
Sherritt Gordon (flowsheet) ... 1958: 73
Where ion exchange fits in hydrometallurgy Mindler & Paulson (chart & tables) 1955: 56

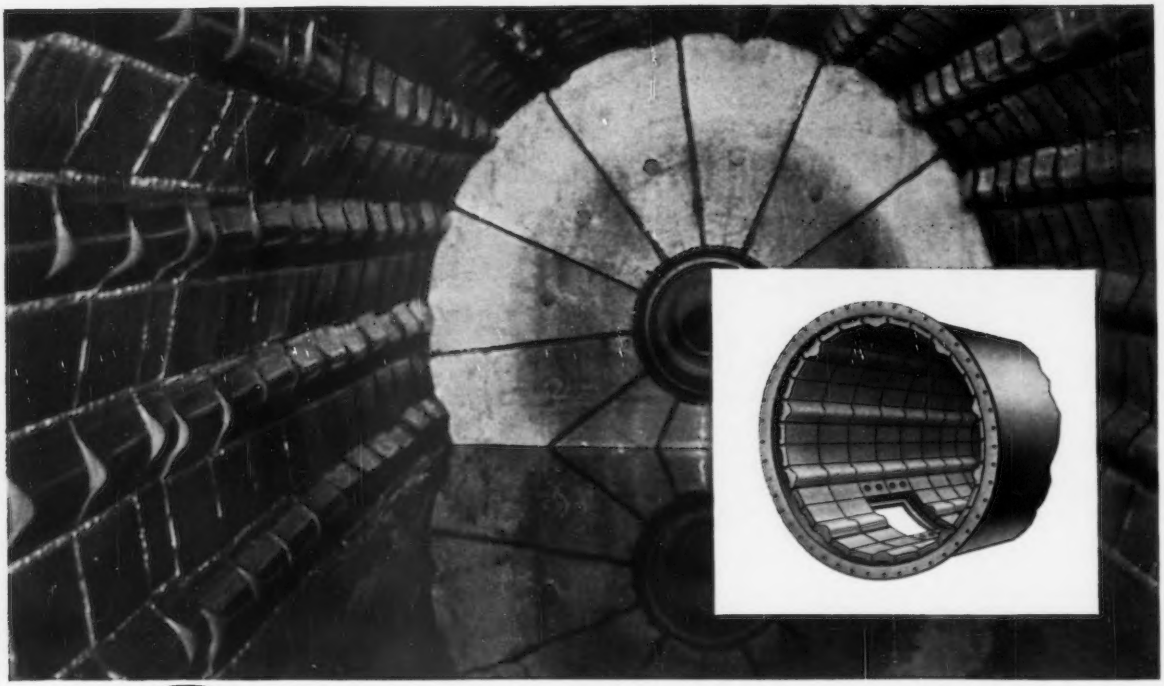
Mining also see: Exploration; Open Pit Mining & Quarrying; Placer Mining & Dredging; Underground Mining; Wells & other Special Mining
Boning up on blasting; Reflection Theory 1958: 102
Chart your breaking cost to get the full picture ... 1958: 105
Checklist of drill steel (table) ... 1958: 113
Checklist of loaders (table) ... 1958: 100
Explosives and their applications (tables) 1956: 90
Explosives and their applications (tables) 1957: 68
Formulae can help plan efficient blasts 1958: 104
How to keep solids flowing in bins and hoppers A. W. Jenike (charts) ... 1955: 83
How to systematize selection of muck handling equipment ... 1957: 74
Is mining making full use of modern electrical equipment and engineering? E. H. Tucker ... 1955: 80
The Mine Office: tools and techniques 1958: 29
Mine power: conductors and circuits 1958: 36
Mining's aim for greater productivity starts with the rock bit ... 1957: 32
Percussion drill steel facts of life ... 1958: 110
Scales in mining: a survey ... 1958: 62
Selecting loading and hauling units 1958: 97

Nickel
Chemical metallurgy solves low-grade, complex ore problems H. L. Talbot ... 1955: 52
Chemical techniques unlock laterites 1955: 54
How Inco produces electrolytic nickel from nickel matte (flowsheet) ... 1958: 95
International Nickel Co. smelter now and then ... 1958: 94
Nickel Processing Corp. Nicaro plant 1957: 118
Sherritt Gordon Mines Ltd. flowsheet 1957: 121
Solution processing of nickel at Sherritt Gordon Mines Ltd. (flowsheet) ... 1958: 73

Office & Supply Services also see: Materials Handling, General
Good filing keeps knowledge at your fingertips ... 1958: 114
The Mine Office: tools and techniques 1958: 29

Open Pit Mining & Quarrying also see: Mining; Placer Mining & Dredging
Case histories of surface drilling and blasting (table) ... 1958: 106
Drilling and blasting (tables) ... 1954: G 7

(Continued on p. 243)



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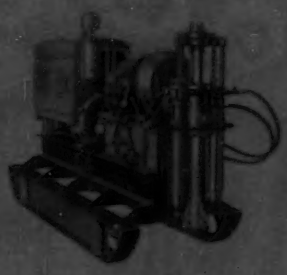

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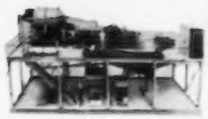
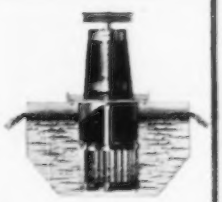
 **WEMCO MOBIL-MILL**	Widely used for profitable production of marketable concentrates and low cost elimination of waste in treating metallic minerals, industrial minerals, coal and aggregate. Pre-engineered and pre-fabricated for maximum flexibility. Incorporates Wemco Drum type and Cone type separators for most accurate separations and highest recoveries.	Specific Gravity Range: 1.25 to 3.40 Capacity: 5 to 500 TPH Separatory Vessel: Cone, Single Drum, Double Drum, 2-Compartment Drum.
 **WEMCO FAGERGREN FLOTATION MACHINE**	World standard of flotation in major operations with maximum capacity per cubic foot of floor space. Rotor-stator principle gives optimum pulp circulation and aeration for high metallurgical efficiency. New air control for increased cleaning efficiency. Special feed boxes eliminate costly pumping. Minimum adjustments.	Sizes: 12" to 66" Capacity: 1 to 50,000 TPD Rotor-Stator: Rubber or neoprene covered, stainless or alloy iron. Tank: Steel, wood, stainless, cement or rubber lined.
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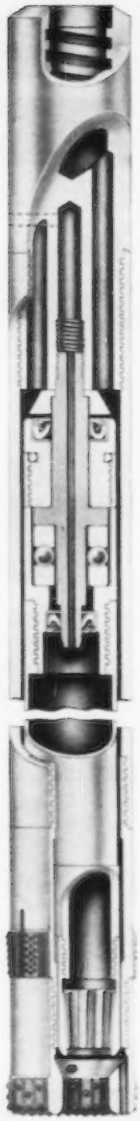

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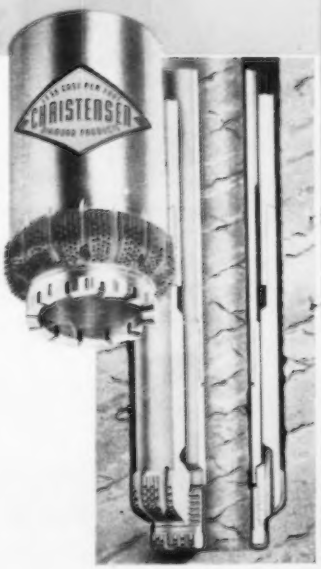

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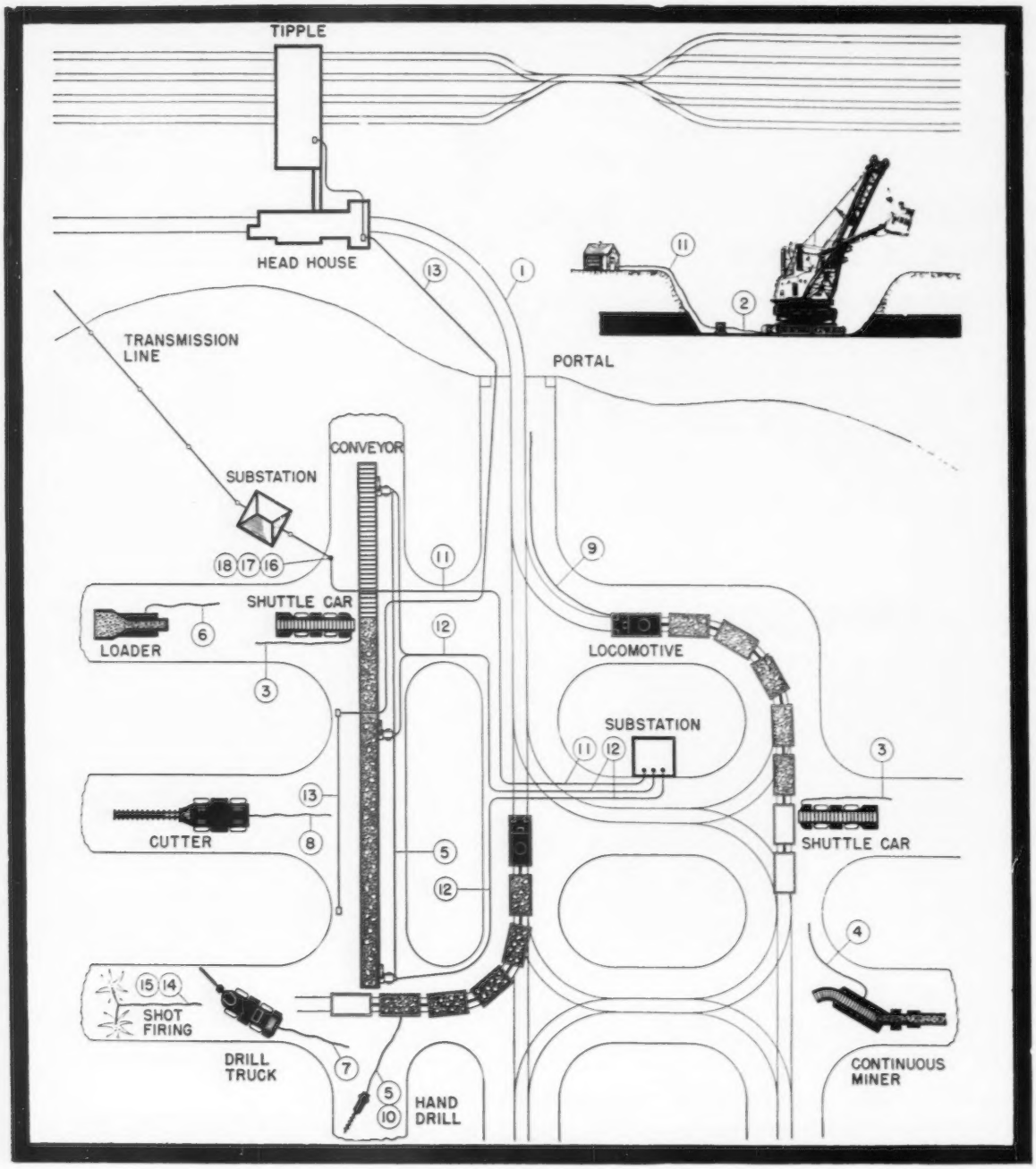

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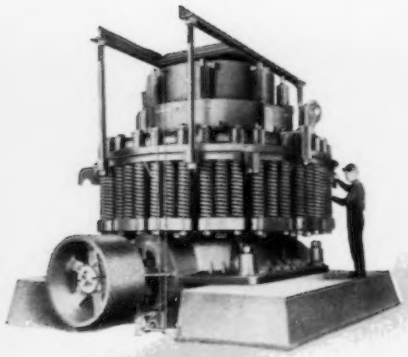
The many years of specialized experience gained by Nordberg in working closely with the mining fraternity has resulted in continual design and operational improvements which have consistently made Nordberg Machinery first choice among the world's leading ore and mineral producers.

As illustrated, Nordberg Mining Machinery includes Symons® Gyratory Crushers for primary breaking, Symons Cone Crushers for secondary and tertiary crushing, Nordberg Mills for wet or dry grinding, Symons Vibrating Grizzlies and Screens for scalping and sizing, and Nordberg Engines for mine and mill power.

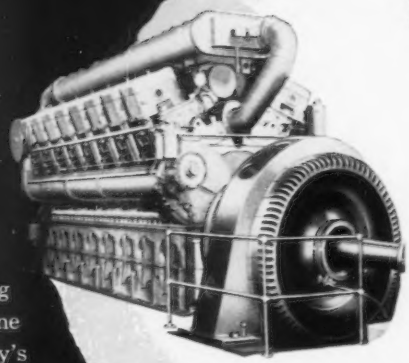
Write for literature on the Nordberg Machinery you need to efficiently produce large tonnages of ores and industrial minerals at lower cost per ton.

SYMONS . . . A Registered Nordberg Trademark known throughout the world

NORDBERG MFG. CO.
Milwaukee, Wisconsin



SYMONS CONE CRUSHERS
Built in both Standard and Short Head types, in sizes from 22" to 7' in diameter, in capacities from 6 to 900 or more tons per hour.



NORDBERG ENGINES
Ranging from small power units to large stationary engines. Nordberg engines are built in types for Diesel, Duafuel® and Spark-Ignition Gas operation, in sizes to over 12,000 horsepower.

SYMONS ROD DECK SCREENS
Highly efficient screening surface of spring steel rods—easily replaced. Especially suited for wet, sticky materials.

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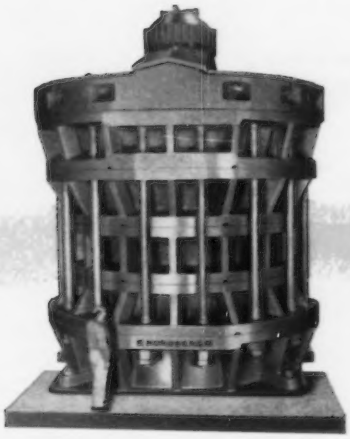
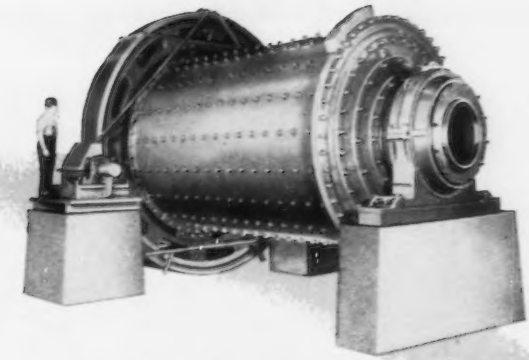


SYMONS® PRIMARY GYRATORY CRUSHERS

Built in 30″, 42″, 48″, 54″, 60″ and 72″ feed opening sizes, for capacities to 3500 or more tons per hour.

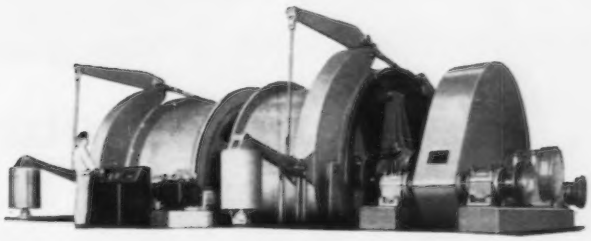


NORDBERG GRINDING MILLS

Built for wet or dry, open or closed circuit operation . . . including Rod, Ball, Pebble, Tube and Compartment types, in sizes from 6′ to 13′ dia., up to 50′ in length.

NORDBERG MINE HOISTS

Built in both friction and drum types for hoisting both ore and men. These dependable hoists are widely used in large coal and metal mining operations.

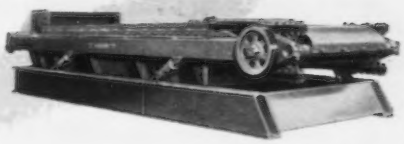


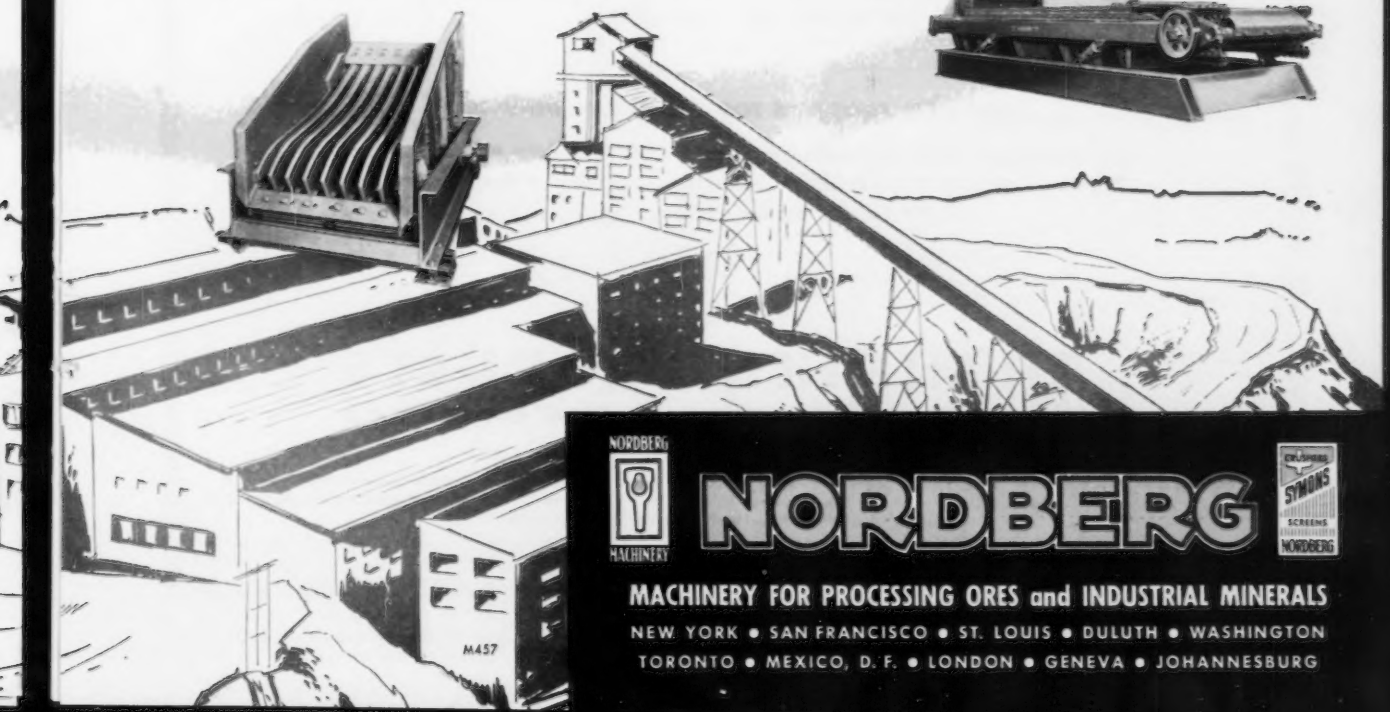
SYMONS VIBRATING BAR GRIZZLIES

Built for heavy duty large capacity primary scalping service. Particularly effective when handling wet, sticky or gummy ores.

SYMONS HORIZONTAL VIBRATING SCREENS

Permit level, large capacity screening of extreme accuracy. Built in single, double and triple deck types in a wide range of widths and lengths.





NORDBERG MACHINERY

NORDBERG

SYMONS SCREENS NORDBERG

MACHINERY FOR PROCESSING ORES and INDUSTRIAL MINERALS

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"Not merely to sell; but to serve . . . not only to make good steel products; but to make them still better . . . not only to fulfill today's requirements; but to anticipate tomorrow's—these are the principles that constantly guide CF&I."

G. F. Franz

President

We've taken our own advice

When any business is "soft", management often uses this period to clean house. All operating methods are examined carefully with an eye toward increasing efficiency by revising or eliminating those practices that hamper productivity—practices that could not be corrected during peak periods.

In the past, there have been times when the demand for CF&I Mining Products has exceeded our capacity, and you have had to wait for deliveries. More recently, demand has been off somewhat, and we have utilized this period to improve our own production efficiency, and new equipment has been added to increase our volume. Now we are in a position, when the demand again picks up, to offer you greater production and quicker deliveries from our enlarged stocks of mining products. Thus, we have "anticipated tomorrow's requirements"—we have taken our own advice.

CF&I STEEL PRODUCTS FOR THE MINING INDUSTRY

CF&I Grinding Balls • CF&I Grinding Rods • CF&I Rock Bolts • Wickwire Rope
CF&I Mine Rails and Accessories • CF&I Industrial Screens • Realock Fence and Fabric • Grader Blades and other Cutting Edges

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THE COLORADO FUEL AND IRON CORPORATION

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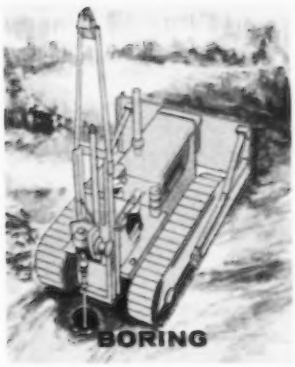
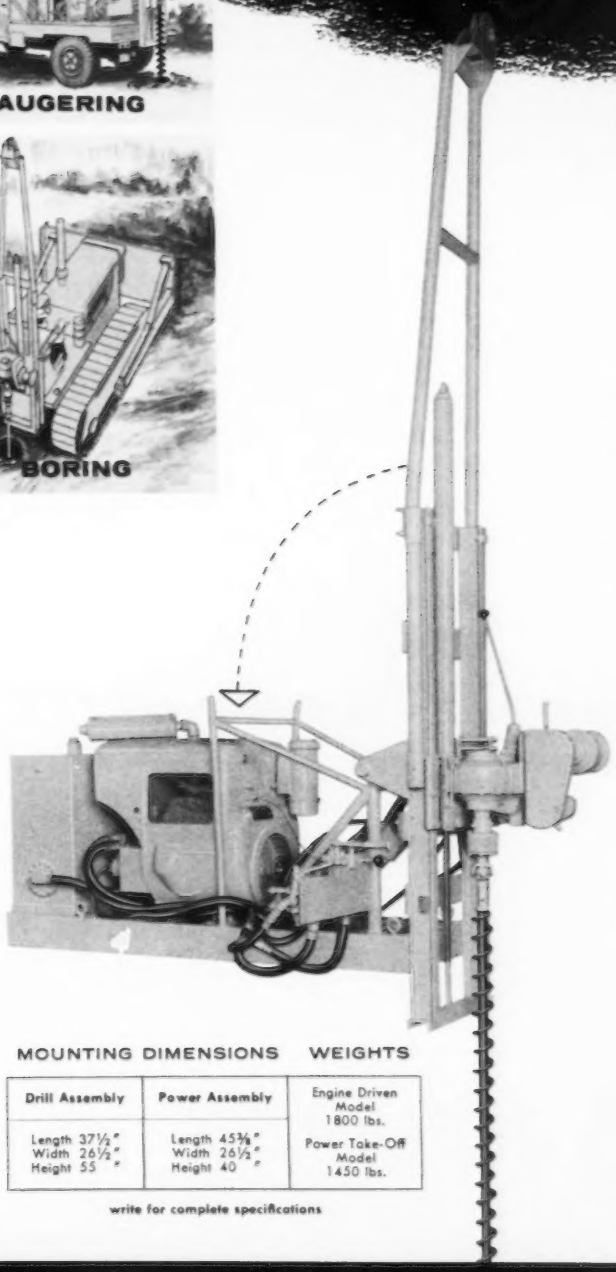
CORING

AUGERING



BORING

Introducing Mobile Drill's B-40 "EXPLORER"



It's designed to do **ALL** these drilling jobs:

- **Auger Drill to 75 Feet**
- **Core Drill to 500 Feet**
- **Bore Holes up to 24″ Dia.**

You name the drilling job and the B-40 "Explorer" can do it—*fast!* It's Mobile Drill's advanced design triumph—light and compact, yet rugged enough to handle the toughest assignments with ease. You can take this agile unit into spots where even a mountain goat might hesitate to go . . . mounts on any ½ ton truck, skid, rubber or crawler tractor.

The "Explorer" is specifically designed to do high-torque continuous flight augering to 75 ft., core drilling to 500 feet, and earth boring up to 24″ in diameter. Use it for both disturbed and undisturbed soil sampling. Quickly convertible from one type of drilling to another.

Never Before—So Many Advantages at So Little Cost

- Mounting Flexibility—compact "Explorer" fits any available carrier, ½ ton or heavier.
- Has independent power plant—4-cyl., 36-hp, air cooled engine. Also available without engine for mounting on PTO-equipped vehicles.
- Powerful hydraulic cylinder delivers 68″ stroke with ram pressure of 7069 lbs. up and 6283 lbs. down.
- Hydraulic rotary head drive is geared to assure positive drilling action. Drilling speed range: 62 to 500 r.p.m. with maximum torque of 1740 lbs.
- Simple, conveniently located controls permit one-man operation.
- No clearance problems—drill frame and tower lower to horizontal travelling position (55″), only inches above carrier cab.

MOUNTING DIMENSIONS WEIGHTS

Drill Assembly	Power Assembly	Engine Driven Model 1800 lbs.
Length 37½″ Width 26½″ Height 55 ″	Length 45¾″ Width 26½″ Height 40 ″	Power Take-Off Model 1450 lbs.

write for complete specifications

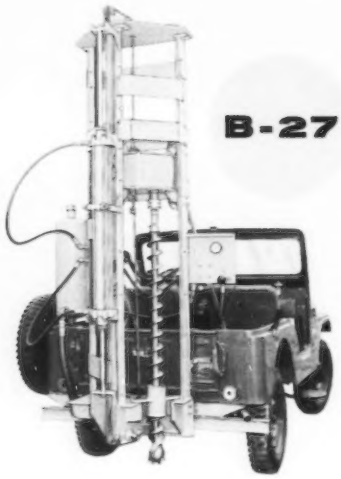
APPLICATIONS UNLIMITED

Clay and mineral prospecting • Aggregate prospecting
Subsoil testing for highways and bridges
Foundation testing for heavy structures
Preboring for foundation pilings • Post hole boring
Diamond core drilling • Penetration tests

The B-40 "Explorer" is the newest member of the Mobile Drill family—drilling units specified throughout the world for MODERN MOBILITY

modern mobility

in the world's greatest array of hydraulic drilling rigs



B-27

Lightweight auger designed for exploratory work. Mounts on Jeep or similar PTO-equipped vehicle. Highly maneuverable . . . goes anywhere a Jeep can go . . . moves from job to job with no wasted set-up time. Quick-change feature permits horizontal augering too. Simple, safe one-man operation.

Brief B-27 Specifications

Type of feed	Hydraulic
Stroke	68"
Spindle speed range	45-550 rpm
Hole diameter	3" to 6"
Hole depth	75 ft.
Max. torque output	862 ft.-lbs.
Rate of free feed	30 fpm
Net weight	800 lbs.

B-36

A rugged PTO-driven auger for drilling to depths of 100 feet. Mounts on any ¾-ton or heavier vehicle. 6-ft. stroke and 8000 lbs. ram and lift pressure enable the B-36 to auger 700 feet in an average day. Separate drill clutch saves wear and tear on vehicle clutch. Centralized control panel permits one man operation.

B-36 Specifications

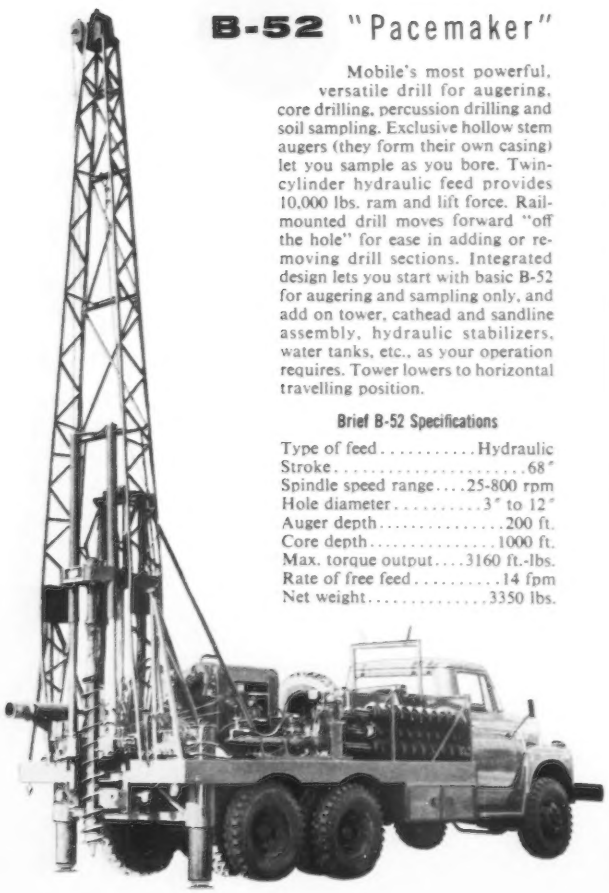
Type of feed	Hydraulic
Stroke	68"
Spindle speed range	50-500 rpm
Hole diameter	3" to 8"
Hole depth	100 ft.
Max. torque output	862 ft.-lbs.
Rate of free feed	15 fpm
Net weight	780 lbs.

B-52 "Pacemaker"

Mobile's most powerful, versatile drill for augering, core drilling, percussion drilling and soil sampling. Exclusive hollow stem augers (they form their own casing) let you sample as you bore. Twin-cylinder hydraulic feed provides 10,000 lbs. ram and lift force. Rail-mounted drill moves forward "off the hole" for ease in adding or removing drill sections. Integrated design lets you start with basic B-52 for augering and sampling only, and add on tower, cathead and sandline assembly, hydraulic stabilizers, water tanks, etc., as your operation requires. Tower lowers to horizontal travelling position.

Brief B-52 Specifications

Type of feed	Hydraulic
Stroke	68"
Spindle speed range	25-800 rpm
Hole diameter	3" to 12"
Auger depth	200 ft.
Core depth	1000 ft.
Max. torque output	3160 ft.-lbs.
Rate of free feed	14 fpm
Net weight	3350 lbs.



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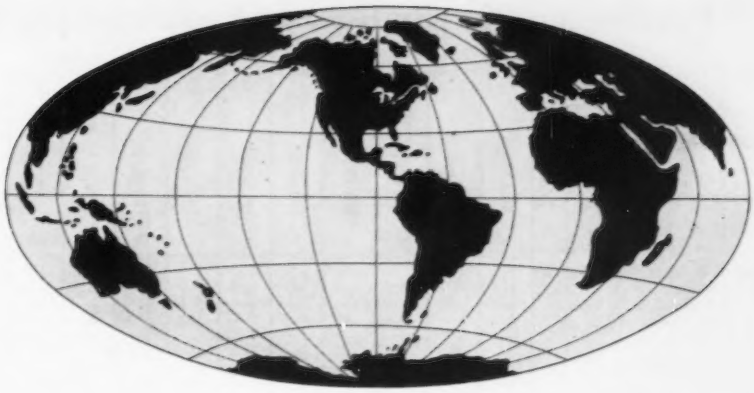


How to Use Your 1958 E&MJ Guidebook

THE FIFTH E&MJ MINING GUIDEBOOK and Mining Directory is dedicated to more efficient mining at lower costs. In it you will find suggested equipment and techniques to help you do your job better—with emphasis on the "How to . . ."

Minerals are found, and are being found to a greater extent, all over the world. The next four pages contain tables compiled by the Department of Interior which show how most of the important mineral wealth is distributed. Standards of living in the Free World are growing, and mining must supply the material for growth. The 1958 Guidebook, like its predecessors, follows the general pattern from ore discovery, through mining methods, processing, and the various auxiliary jobs which are vital to a modern operation.

Previous Guidebooks (see composite index of issues 1954 through 1958 on pages six and seven) have discussed modern tools and techniques of exploration in full detail. This issue places emphasis on ore deposits and their classification and discusses the mine office.

Seven pages are devoted to suggested tools for the modern mining engineer and his office. They range from simplified drafting instruments through transists and magnetometers to analog computers and drill hole surveying. In the field of aerial surveying alone, great strides are being made constantly to improve accuracy, cut operating time and reduce costs.

Bringing electric power underground can simplify many mining operations and introduce many an' varied types of equipment to difficult problems. Thi' .ssue contains 26 pages of information on conductors, c..oles and power. Types of conductors manufactured, applications, limitations and improved design are all discussed fully, along with full discussion of the various safety problems and precautions which must be taken both by the operator and his staff.

A second survey, devoted to scales in the mining industry, produced another application story. Where do mine operators put their scales, how is productivity measured, which scale performs best in a given situation for a given product? All these questions were answered by the operators of some of the major U.S. mines.

Modern mineral processing, as represented by mills in all the important producing areas of the world, working on the very oldest and the very newest minerals is discussed in 32 pages of flowsheets which start on p 65. The editors have gathered processing data from industry meetings, mine plant visits, submitted manuscripts and major foreign publications to give you, in one collection, the latest methods and machinery for higher recovery at reduced cost.

Muckhandling and loading are still two of the first places to look when you seek more efficient operation. Major equipment manufacturers have supplied the latest information available for the article which starts on p 97. This, coupled with information in previous Guidebooks, will give you a firm basis for comparing your methods with those in current use at the smoothest operating mines in the industry.

How are today's mines taking advantage of new blasting materials and techniques? Page 102 is the lead-off to an eight-page section of this issue devoted to the results of an editor's survey of major mining companies.

Drill steel performance, and how it gets that way, has a direct bearing on your drilling costs and drilling time. Reaction to an article in *E&MJ* (November 1957, p 90), prompted the inclusion of the article on p 110, expanded in scope and with a bibliography of important past discussions.

Your mining library, if it is well organized and easily accessible, is one of the most important tools of the trade. On pages 114-116, the editors have illustrated the method used by *E&MJ* to catalog and classify the wide field of technology served by this magazine. Each issue of *E&MJ*, and particularly the Guidebook issues, are designed to contribute to a timely and constantly useful body of information.

In particular, the Guidebooks are organized to complement each other, discussing yearly improvements in the general areas of mining methods and specifically covering a given segment in detail in each year. The index on pages six and seven is organized according to the catalog system which appears on p 114. By using that index, and the five Guidebooks, you can begin to keep pace with new technology, new equipment and new ideas as they appear on the international mining horizon.

The Buyers' Directory published in this issue represents more than 2,000 questionnaires sent to the leading manufacturers and service companies in the mining industry. Their products and services have been catalogued and listed to help you find what you want quickly and simply. The Buyers' Directory, like the previous four E&MJ Guidebooks, should be a part of your permanent mining library.

Percentage Distribution, by Countries and Geographic Areas, of

	Aluminum	Antimony	Asbestos	Bauxite	Beryllium	Bismuth	Cadmium	Chromite	Cobalt	Columbium-tantalum	Copper, mine	Copper, smelter	Corundum	Diamonds, industrial	Fluorspar	Graphite	Iron ore
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
North & Central America:																	
1 Canada	16.6	1.7	59.3	—	—	5.6	11.8	—	11.5	—	9.5	8.4	—	—	8.8	—	5.1
2 Greenland	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3 Guatemala	—	—	—	—	—	—	0.6	*	—	—	—	—	—	—	—	—	—
4 Honduras	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5 Mexico	—	9.3	—	—	—	28.6	—	—	—	—	1.6	1.3	—	—	*21.0	12.1	0.2
West Indies:																	
6 Cuba	—	—	—	—	—	—	—	†1.4	—	—	0.4	—	—	—	—	—	0.1
7 Dominican Republic	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.1
8 Jamaica	—	—	—	18.1	—	—	—	—	—	—	—	—	—	—	—	—	—
9 Trinidad	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10 United States	45.3	1.0	2.4	10.0	3.7	N.A.	55.0	4.9	7.9	2.3	29.5	31.1	—	—	19.2	N.A.	25.2
Total	**61.9**	**12.0**	**61.7**	**28.1**	**3.7**	**N.A.**	**67.4**	**6.3**	**19.4**	**2.3**	**41.0**	**40.8**	**—**	**—**	**49.0**	**N.A.**	**30.7**
South America:																	
11 Argentina	—	*	*	—	13.8	†0.2	—	—	—	0.1	—	—	N.A.	—	0.8	0.1	*
12 Bolivia (exports)	—	10.4	*	—	—	1.5	—	—	—	—	0.1	—	—	—	*	—	—
13 Brazil	0.2	—	†0.2	0.3	15.9	N.A.	—	†0.1	—	‡3.1	—	—	—	†0.8	—	N.A.	0.8
14 British Guiana	—	—	—	14.3	—	—	—	—	—	—	—	—	—	0.1	—	—	—
15 Chile	—	—	*	—	—	—	—	—	—	—	14.4	12.8	—	—	—	—	0.7
16 Colombia	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.1
17 Ecuador	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
18 French Guiana	—	—	—	—	—	—	—	—	—	‡0.2	—	—	—	—	—	—	—
19 Peru	—	1.7	—	—	—	13.0	0.7	—	—	—	1.3	0.9	—	—	—	—	0.7
20 Surinam	—	—	—	19.7	—	—	—	—	—	—	—	—	—	—	—	—	—
21 Uruguay	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
22 Venezuela	—	—	0.4	—	—	—	—	—	—	—	—	—	—	0.4	—	—	2.8
Total	**0.2**	**12.1**	**0.6**	**34.3**	**29.7**	**N.A.**	**0.7**	**†0.1**	**—**	**3.4**	**15.8**	**13.7**	**N.A.**	**1.3**	**0.8**	**N.A.**	**5.1**
Europe, Western:																	
23 Austria	1.8	0.8	—	0.2	—	—	—	—	—	—	*	0.3	—	—	—	7.6	0.8
24 Belgium	—	—	—	—	—	—	5.8	—	—	—	—	—	—	—	†0.3	—	0.1
25 Finland	—	—	0.5	—	—	—	—	—	N.A.	—	0.6	0.6	—	—	—	—	0.1
26 France	4.4	†0.2	0.6	8.3	*	2.9	1.3	—	—	—	*	*	—	—	5.2	—	13.4
27 Germany, West	4.4	—	*	*	—	—	3.4	—	—	—	0.3	7.1	—	—	10.0	4.7	4.3
28 Greece	—	†0.2	*	4.0	—	—	—	1.1	—	—	—	—	—	—	—	—	0.1
29 Ireland	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
30 Italy	1.9	0.5	2.1	1.5	—	—	2.1	—	—	—	*	*	—	—	8.0	1.2	0.4
31 Luxembourg	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.9
32 Netherlands	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
33 Norway	2.7	—	—	—	—	—	1.5	—	—	5.9	0.4	0.4	—	—	*	2.0	0.4
34 Portugal	—	—	*	—	1.6	—	—	—	—	‡0.4	*	—	—	—	—	—	0.1
35 Spain	0.4	†0.4	—	*	—	†2.8	0.1	—	—	—	0.2	0.2	—	—	†3.9	0.1	1.1
36 Sweden	0.4	—	—	—	—	†1.6	—	—	—	—	0.5	0.5	—	—	*	†0.1	4.8
37 Switzerland	1.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	*
38 United Kingdom	0.8	—	—	—	—	—	1.3	—	—	—	—	—	—	—	4.7	—	4.2
39 Yugoslavia	0.4	3.4	0.3	5.0	—	5.0	—	3.0	—	—	0.9	0.8	—	—	—	—	0.4
Total	**18.2**	**5.5**	**3.5**	**19.0**	**1.6**	**12.3**	**15.5**	**4.1**	**†5.5**	**6.3**	**2.9**	**9.9**	**—**	**—**	**32.1**	**15.7**	**32.1**
Asia:																	
40 Afghanistan	—	—	—	—	0.2	—	—	—	—	—	—	—	—	—	—	—	—
41 Bahrein Island	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
42 Burma	—	†0.1	—	—	—	—	—	—	—	—	*	—	—	—	—	—	P
43 Ceylon	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	*6.2	—
44 Cyprus (exports)	—	—	0.8	—	—	—	—	*0.1	—	—	1.1	—	—	—	—	—	—
45 Hong Kong	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.0	*
46 India	0.2	—	0.1	0.6	‡27.0	—	—	1.4	—	—	0.2	0.2	3.6	*	—	†0.6	1.2
47 Indochina	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
48 Indonesia	—	—	—	1.7	—	—	—	—	—	—	—	—	—	—	—	—	—
49 Iran	—	†0.1	*	—	—	—	—	0.7	—	—	—	—	—	—	—	—	*
50 Iraq	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
51 Israel	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
52 Japan	2.0	1.1	0.6	—	—	3.2	4.7	1.0	—	—	2.3	2.6	—	—	0.5	1.3	0.5
53 Korea, Republic of	—	—	*	—	—	8.2	—	—	—	—	*	*	—	—	0.2	24.9	*
54 Kuwait (incl. Neut. Zone)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
55 Malaya	—	—	—	1.5	—	—	—	—	—	6.4	—	—	0.9	—	—	—	0.6
56 Pakistan	—	—	—	*	—	—	—	0.6	—	—	—	—	—	—	—	—	—
57 Philippines	—	—	—	—	—	—	—	18.6	—	—	0.8	—	—	—	—	—	0.4
58 Portuguese India	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	*0.5
59 Qatar	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
60 Sarawak and Brunei	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
61 Saudi Arabia	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
62 Taiwan	0.3	—	*	—	—	—	—	—	—	—	*	*	—	—	—	0.8	—
63 Thailand	—	*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	*
64 Turkey	—	6.8	*	—	—	—	—	18.7	—	—	0.7	0.7	—	—	—	—	0.2
Total	**2.5**	**8.1**	**1.5**	**3.8**	**27.2**	**11.4**	**4.7**	**41.1**	**—**	**6.4**	**5.1**	**3.5**	**4.5**	*****	**0.7**	**34.8**	**3.4**
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

World Production of Selected Critical Metals and Minerals in 1956

Lead, mine	Lead, smelter	Magnesium, metal	Manganese Ore	Mercury	Mica, incl. scrap	Molybdenum	Nickel	Petroleum, crude	Platinum-group metals	Potash, K_2O equiv.	Sulphur, native	Talc, pyrophyllite and soapstone	Tin, mine	Tin, smelter	Titanium: Ilmenite	Titanium: Rutile	Tungsten	Vanadium	Zinc, mine	Zinc, smelter	
18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	
7.8	6.3	†6.2	—	—	0.4	1.3	77.4	2.8	31.8	—	—	1.5	0.2	—	12.5	—	2.3	—	12.6	8.2	1
0.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.1	—	2
0.4	*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.4	—	3
0.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	‡0.1	—	4
9.1	9.0	—	†1.4	9.9	—	0.1	—	1.5	—	—	9.5	—	0.3	0.1	—	—	0.8	—	8.2	2.0	5
*	—	—	°2.1	—	—	—	7.0	*	—	—	—	—	—	—	—	—	—	—	0.1	—	6
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8
—	—	—	—	—	—	—	—	0.5	—	—	—	—	—	—	—	—	—	—	—	—	9
14.6	22.9	43.3	2.9	12.2	56.2	91.1	2.9	42.7	2.1	26.0	81.1	39.5	—	9.7	38.3	9.9	18.1	91.3	16.3	31.5	10
32.2	**38.2**	**49.5**	**6.4**	**22.1**	**56.6**	**92.5**	**87.3**	**47.5**	**33.9**	**26.0**	**90.6**	**41.0**	**0.5**	**9.8**	**50.8**	**9.9**	**21.2**	**91.3**	**37.8**	**41.7**	
1.3	1.1	—	0.1	—	0.1	—	—	0.5	—	—	0.3	1.5	*	0.1	—	—	1.6	†0.2	0.8	0.5	11
0.9	—	—	—	—	—	—	*	0.1	—	—	0.1	—	15.0	0.3	—	—	6.5	—	0.6	—	12
†0.2	0.2	—	2.1	—	†1.0	—	*	0.1	—	—	—	†1.5	†0.1	†0.7	—	°0.1	°2.1	—	—	—	13
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	14
†0.2	—	—	0.4	†0.3	—	4.9	—	0.1	—	0.2	†0.7	—	—	—	—	—	—	—	†0.1	—	15
—	—	—	—	—	—	—	—	0.7	2.6	—	0.1	—	—	—	—	—	—	—	—	—	16
—	—	—	—	—	—	—	—	0.1	—	—	—	—	—	—	—	—	—	—	—	—	17
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	18
5.5	2.8	—	0.1	—	—	—	—	0.3	—	—	—	*	—	—	—	—	1.5	—	5.0	0.3	19
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	20
—	—	—	—	—	—	—	—	—	—	—	—	†0.1	—	—	—	—	—	—	—	—	21
—	—	—	0.1	—	—	—	—	14.7	—	—	—	—	—	—	—	—	—	—	—	—	22
8.1	**4.1**	**—**	**2.8**	**†0.3**	**1.1**	**4.9**	*	**16.6**	**2.6**	**0.2**	**1.2**	**3.1**	**15.1**	**1.1**	**—**	**0.1**	**11.7**	**†0.2**	**6.5**	**0.8**	
0.2	0.5	—	—	*	—	*	—	0.4	—	—	—	4.0	—	—	—	—	—	—	0.2	0.2	23
—	4.7	—	—	—	—	—	—	—	—	—	—	—	—	5.4	—	—	—	—	—	8.1	24
0.1	—	—	—	—	—	—	*	—	—	—	—	0.4	—	—	6.3	—	0.1	1.0	1.3	—	25
0.4	2.9	1.0	—	—	—	—	—	0.2	—	17.4	—	8.0	0.2	—	—	—	1.5	—	0.4	4.0	26
3.0	5.4	0.1	—	—	—	—	—	0.4	—	22.0	—	3.0	—	†0.4	—	—	—	—	3.1	6.6	27
0.5	0.2	—	0.3	—	—	—	†0.2	—	—	—	†0.1	†0.1	—	—	—	—	—	—	0.7	—	28
0.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.1	—	29
2.2	1.8	2.6	0.4	31.4	—	—	—	0.1	—	*	2.2	5.5	—	—	—	—	*	—	4.1	2.6	30
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	31
—	†0.4	—	—	—	—	—	—	0.1	—	—	—	—	—	15.5	—	—	—	—	—	1.0	32
*	—	4.9	—	—	0.9	0.6	—	—	—	—	—	†4.0	—	—	11.7	*	—	—	0.2	1.7	33
*	†0.1	—	*	—	—	—	—	—	—	—	—	*	0.5	0.6	*	—	6.8	—	—	—	34
2.8	2.7	—	0.3	†20.3	*	*	—	—	—	3.1	†0.1	2.0	†0.3	0.3	0.4	—	1.9	P	2.9	0.8	35
1.5	1.1	—	—	—	0.1	—	—	—	—	*	—	1.0	—	—	—	—	0.6	—	2.2	—	36
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	37
0.3	0.3	2.5	—	—	—	—	—	*	—	—	—	†0.3	0.6	14.6	—	—	†0.1	—	*	2.9	38
4.0	3.5	—	†0.1	6.7	—	0.1	—	*	—	—	—	—	—	—	—	—	†0.1	—	1.9	0.5	39
15.1	**23.6**	**11.1**	**1.1**	**58.4**	**1.0**	**0.7**	**†0.2**	**1.2**	**—**	**42.5**	**2.4**	**28.3**	**1.6**	**36.8**	**18.4**	*	**11.1**	**1.0**	**17.1**	**28.4**	
—	—	—	—	—	—	—	—	—	—	—	—	0.1	—	—	—	—	—	—	—	—	40
—	—	—	—	—	—	—	—	0.2	—	—	—	—	—	—	—	—	—	—	—	—	41
0.7	0.9	—	*	—	—	—	0.1	*	—	—	—	—	0.6	—	—	—	3.7	—	0.2	—	42
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	43
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	44
*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	*	—	—	—	45
0.1	0.1	—	15.0	—	°15.5	—	—	0.1	—	—	—	2.0	—	—	21.0	0.5	—	—	0.1	—	46
—	—	—	—	—	—	—	—	—	—	—	—	—	0.1	—	—	—	—	—	—	—	47
—	—	—	0.7	—	—	—	—	1.5	—	—	—	—	16.7	†0.8	—	—	—	—	—	—	48
†0.8	*	—	*	—	—	—	*	3.2	—	—	—	—	—	—	—	—	—	—	0.1	—	49
—	—	—	—	—	—	—	—	3.8	—	—	—	—	—	—	—	—	—	—	—	—	50
—	—	—	—	—	—	—	—	*	—	†0.4	—	—	—	—	—	—	—	—	—	—	51
1.4	1.7	0.9	2.4	4.2	—	0.8	—	*	0.4	*	3.1	†16.5	0.5	0.6	0.5	—	1.0	—	4.1	4.8	52
*	—	—	*	—	—	0.1	—	—	—	—	—	1.0	—	—	—	—	5.8	—	*	—	53
—	—	—	—	—	—	—	—	6.7	—	—	—	—	—	—	—	—	—	—	—	—	54
—	—	—	—	—	—	—	—	—	—	—	—	—	34.7	40.4	°7.7	—	0.1	—	—	—	55
—	—	—	—	—	—	—	—	*	—	—	—	—	—	—	—	—	—	—	—	—	56
0.1	—	—	*	1.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	*	—	57
—	—	—	°1.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	58
—	—	—	—	—	—	—	—	0.7	—	—	—	—	—	—	—	—	—	—	—	—	59
—	—	—	—	—	—	—	—	0.7	—	—	—	—	—	—	—	—	—	—	—	—	60
—	—	—	—	—	—	—	—	5.9	—	—	—	—	—	—	—	—	—	—	—	—	59
—	—	—	—	—	*	—	—	*	—	—	0.1	0.4	—	—	—	—	—	—	—	—	62
0.2	—	—	*	—	—	—	—	—	—	—	—	—	7.0	—	*	—	1.7	—	*	—	63
0.1	—	—	0.4	0.3	—	—	—	*	—	—	0.1	—	—	—	—	—	—	—	*	—	64
3.4	**2.7**	**0.9**	**19.9**	**6.0**	**15.5**	**0.9**	**0.1**	**22.8**	**0.4**	**†0.4**	**3.3**	**20.0**	**59.6**	**41.8**	**29.2**	**0.5**	**12.3**	**—**	**4.5**	**4.8**	
18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	

See following page for footnotes.

Percentage Distribution, by Countries and Geographic Areas, of

		Aluminum	Antimony	Asbestos	Bauxite	Beryllium	Bismuth	Cadmium	Chromite	Cobalt	Columbium-tantalum	Copper, mine	Copper, smelter	Corundum	Diamonds, industrial	Fluorspar	Graphite	Iron ore
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Africa:																		
65	Algeria	—	4.2	—	—	—	—	—	—	—	—	*	—	—	—	—	—	0.7
66	Angola	—	—	—	—	—	—	—	—	—	—	*	*	—	1.6	—	—	—
67	Bechuanaland	—	—	0.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
68	Belgian Congo	—	—	—	—	†14.2	—	3.2	—	62.7	[i]17.8	7.4	7.0	—	72.6	—	—	—
69	Br. Somaliland	—	—	—	—	[e]0.1	—	—	—	—	—	—	—	—	—	—	—	—
70	Egypt	—	—	—	—	—	—	—	*	—	—	—	—	—	—	—	—	P
71	Ethiopia	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
72	French Cameroon	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
73	Fr. Equatorial Africa	—	—	—	—	—	—	—	—	—	—	—	—	—	0.5	—	—	—
74	French Morocco	—	—	*	—	—	—	—	—	4.4	—	*	—	—	—	*	—	0.1
75	French West Africa	—	—	—	2.6	—	—	—	—	—	—	—	—	—	1.4	—	—	0.2
76	Gold Coast (exports)	—	—	—	0.8	—	—	—	—	—	—	—	—	—	†7.7	—	—	—
77	Kenya	—	—	*	—	—	—	—	—	—	—	—	—	—	—	—	0.2	—
78	Liberia	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.5
79	Madagascar	—	—	—	—	1.6	—	—	—	—	0.2	—	—	—	—	—	5.8	—
80	Mozambique	—	—	*	*	7.6	*	—	—	—	0.5	—	—	—	—	—	—	—
81	Nigeria	—	—	—	—	—	—	—	—	—	60.9	—	—	—	—	—	—	—
82	Rhodesia and Nyasaland, Fed. of	—	0.1	7.0	—	5.0	—	0.6	10.7	8.0	0.4	11.9	10.9	40.3	—	0.1	—	*
83	Sierra Leone	—	—	—	—	—	—	—	[e]0.5	—	—	—	—	—	†4.3	—	—	[e]0.3
84	South-West Africa	—	—	—	—	3.7	*	—	—	—	0.1	0.8	—	—	0.5	—	†0.3	—
85	Spanish Morocco	—	0.6	—	—	—	—	—	—	—	—	—	—	—	—	—	*	0.4
86	Swaziland	—	—	1.8	—	—	—	—	—	—	—	—	—	—	—	—	—	—
87	Tanganyika	—	—	—	—	—	—	—	—	—	—	*	—	—	1.0	—	*	—
88	Tunisia	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.3
89	Uganda	—	—	*	—	[e]0.8	*	—	—	—	0.1	—	—	—	—	—	—	—
90	Union of South Africa	—	29.0	8.0	—	1.1	—	—	16.5	—	*	1.4	1.2	18.8	9.1	2.0	†0.6	0.5
	Total	**—**	**33.9**	**16.9**	**3.4**	**34.1**	*	**3.8**	**27.7**	**75.1**	**80.0**	**21.5**	**19.1**	**59.1**	**98.7**	**2.1**	**6.9**	**3.0**
Oceania:																		
91	Australia	0.3	0.6	0.6	*	2.8	*	3.3	0.1	*	1.6	1.6	1.4	—	*	*	*	1.0
92	Fiji Islands	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
93	New Caledonia	—	—	—	—	—	—	—	1.2	—	—	—	—	—	—	—	—	*
94	New Guinea	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
95	New Zealand	—	—	*	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Total	**0.3**	**0.6**	**0.6**	*	**2.8**	*	**3.3**	**1.3**	*	**1.6**	**1.6**	**1.4**	—	*	*	*	**1.0**
	TOTAL, Free World	**83.1**	**72.2**	**84.8**	**88.6**	**99.1**	**N.A.**	**95.4**	**80.6**	**100.0**	**100.0**	**87.9**	**88.4**	**N.A.**	**100.0**	**84.7**	**N.A.**	**75.3**
USSR and Satellites: (Estimate)																		
96	Albania	—	—	—	—	—	—	—	3.4	—	—	—	—	—	—	—	—	—
97	Bulgaria	—	—	0.1	—	—	—	—	0.2	—	—	—	—	—	—	—	—	0.1
98	Czechoslovakia	0.6	3.2	0.2	—	—	—	—	—	—	—	—	—	—	—	—	4.1	0.5
99	East Germany	1.0	—	—	—	—	—	—	—	—	—	0.6	0.8	—	—	5.1	—	0.4
100	Hungary	1.0	0.1	—	5.1	—	—	—	—	—	—	0.1	—	—	—	—	—	0.1
101	Poland	0.4	—	—	—	—	—	2.8	—	—	—	—	—	—	—	—	—	0.5
102	Rumania	0.2	—	—	0.1	—	—	—	0.2	—	—	—	—	—	—	—	—	0.2
103	USRR (incl. Sakhalin)	13.4	P	14.2	6.2	0.9	4.4	1.8	15.6	—	—	11.1	10.5	N.A.	*	6.4	14.2	19.8
104	China	0.3	24.5	0.7	—	—	4.4	—	—	—	—	0.3	0.3	—	—	3.2	4.0	2.8
105	North Korea	—	—	—	—	—	—	—	—	—	—	—	*	—	—	0.6	6.1	0.3
	TOTAL, USSR and Satellites (Estimate)	**16.9**	**27.8**	**15.2**	**11.4**	**0.9**	**8.8**	**4.6**	**19.4**	**—**	**—**	**12.1**	**11.6**	**N.A.**	*	**15.3**	**28.4**	**24.7**
	Unidentified	**—**	**—**	**—**	**—**	**—**	**18.6**	**—**	**—**	**—**	**—**	**—**	**—**	**36.4**	**—**	**—**	**2.0**	**—**
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
	WORLD TOTALS	3,365,000 M. T.	49,000 M. T.	1,550,000 M. T.	17,650,000 M. T.	11,300 M. T.	2,200,000 kg	8,630,000 kg	3,800,000 M. T.	14,500 M. T.	9,640,000 lb	3,400,000 M. T.	3,590,000 M. T.	10,000 M. T.	18,300,000 M. Carats	1,560,000 M. T.	245,000 M. T.	394,100,000 M. T.
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

* — Less than 0.1%.

† — Estimate.

[e] — Exports.

[i] — United States imports.

N.A. — Not available; but estimates have been included in the total.

P — Production unknown; no estimates included in the total.

World Production of Selected Critical Metals and Minerals in 1956

(CONTINUED)

Lead, mine	Lead, smelter	Magnesium, metal	Manganese Ore	Mercury	Mica, incl. scrap	Molybdenum	Nickel	Petroleum, crude	Platinum-group metals	Potash, K_2O equiv.	Sulphur, native	Talc, pyrophyllite and soapstone	Tin, mine	Tin, smelter	Titanium: Ilmenite	Titanium: Rutile	Tungsten	Vanadium	Zinc, mine	Zinc, smelter	
18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	
0.5	—	—	—	—	—	—	—	*	—	—	—	—	—	—	—	—	—	—	1.0	—	65
—	—	—	0.3	—	0.3	—	—	*	—	—	—	—	—	—	—	—	—	0.3	*	—	66
*	—	—	3.0	—	—	—	—	—	—	—	—	—	8.1	1.6	—	—	*2.3	—	3.8	1.5	67
*	—	—	0.2	—	—	—	—	0.2	*	*	—	0.4	—	—	*	—	—	—	*	—	68
—	—	—	—	—	—	—	—	—	—	—	—	—	*	—	—	0.1	—	—	—	—	69
0.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	70
4.0	1.3	—	3.8	—	—	—	*	*	—	—	—	—	*	*	1.2	0.6	*	P	1.3	—	71
—	—	—	5.8	—	—	—	—	—	—	—	—	—	*	—	—	—	—	—	—	—	72
—	—	—	—	—	0.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	73
—	—	—	—	—	*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	74
*	—	—	—	—	—	—	—	—	—	—	—	—	5.0	—	—	—	*	—	—	—	75
0.7	0.7	—	0.4	—	*	—	P	—	—	—	—	—	0.2	*	—	—	0.4	—	1.2	1.0	76
4.5	—	—	0.5	—	—	—	—	—	—	—	—	—	0.3	—	—	—	0.2	7.2	0.6	—	77
*	—	—	*	—	—	—	—	—	—	—	—	—	*	—	—	—	—	—	—	—	78
—	—	—	—	—	—	—	—	—	—	—	—	—	*	—	—	—	—	—	—	—	79
*0.3	—	—	—	—	*0.1	—	—	—	—	—	—	—	*	—	—	—	*	—	—	—	80
1.1	1.2	—	—	*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.2	—	81
**	—	—	—	—	—	—	—	—	—	—	—	—	**	—	—	—	*0.2	—	—	—	82
*	—	—	6.4	—	1.6	—	1.6	—	50.3	—	—	0.1	0.8	0.4	†0.1	—	0.4	—	—	—	83
11.2	**3.2**	**—**	**20.4**	*	**2.3**	**—**	**1.6**	**0.2**	**50.3**	*	**—**	**0.5**	**14.4**	**2.0**	**1.3**	**0.7**	**3.5**	**7.5**	**8.1**	**2.5**	84
13.8	11.2	—	0.6	—	†0.3	—	—	—	*	—	—	0.8	1.2	1.0	0.3	88.8	3.6	—	9.4	3.8	85
—	—	—	†0.2	—	—	—	10.8	—	—	—	—	—	—	—	—	—	—	—	—	—	86
—	—	—	—	—	—	—	—	0.1	*	—	—	—	—	—	—	—	—	—	—	—	87
—	—	—	*	—	—	—	—	*	—	—	—	—	—	—	—	—	*	—	—	—	88
13.8	**11.2**	**—**	**0.8**	**—**	**†0.3**	**—**	**10.8**	**0.1**	*	**—**	**—**	**0.8**	**1.2**	**1.0**	**0.3**	**88.8**	**3.6**	**—**	**9.4**	**3.8**	89
83.8	**83.0**	**61.5**	**51.4**	**86.8**	**76.8**	**99.0**	**100.0**	**88.4**	**87.2**	**69.1**	**97.5**	**93.7**	**92.4**	**92.5**	**100.0**	**100.0**	**63.4**	**100.0**	**83.4**	**82.0**	90
—	—	—	—	—	—	—	—	*	—	—	—	—	—	—	—	—	—	—	—	—	96
1.5	0.3	—	0.7	—	—	—	—	*	—	—	—	—	—	—	—	—	—	—	1.0	0.2	97
0.1	0.3	—	—	0.4	—	—	—	*	—	—	—	—	—	—	—	—	—	—	*	0.3	98
0.3	1.4	—	—	—	—	—	—	—	—	19.1	—	—	0.4	0.3	—	—	—	—	0.2	—	99
*	*	—	0.4	—	—	—	—	0.2	—	—	—	—	—	—	—	—	—	—	—	—	100
1.0	1.0	—	—	—	—	—	—	*	—	—	—	—	—	—	—	—	—	—	4.1	5.4	101
0.5	0.5	—	3.7	P	0.3	*	—	1.3	—	—	—	0.1	—	—	—	—	—	—	0.2	0.2	102
12.0	12.2	38.4	43.1	6.2	17.9	*	P	10.0	12.8	11.8	2.5	1.2	P	P	—	—	10.2	P	10.5	11.3	103
0.7	0.9	0.1	0.7	6.6	5.0	*	—	0.1	—	*	—	5.0	7.2	7.2	—	—	24.4	—	0.6	0.6	104
0.1	0.4	—	—	—	*	*	—	—	—	*	—	—	—	—	—	—	2.0	—	*	—	105
15.2	**17.0**	**38.5**	**48.6**	**13.2**	**23.2**	**†1.0**	**—**	**11.6**	**12.8**	**30.9**	**2.5**	**6.3**	**7.6**	**7.5**	**—**	**—**	**36.6**	**P**	**16.6**	**18.0**	
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
100.0	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	
2,190,000 M. T.	2,150,000 M. T.	140,000 M. T.	11,915,000 M. T.	197,000 flasks	140,000 M. T.	28,600 M. T.	209,559 M. T.	6,125,425,000 bbl	975,000 troy oz	7,600,000 M. T.	8,000,000 L. T.	1,700,000 M. T.	179,660 L. T.	181,400 L. T.	1,623,300 M. T.	110,200 M. T.	73,800 M. T.	3,843 M. T.	3,020,000 M. T.	2,830,000 M. T.	
18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	

Foreign Statistics, Division of Foreign Activities, U. S. Bureau of Mines, Department of the Interior, November, 1957.

SHOULD WE CLASSIFY this copper deposit at Ray, Ariz., as hydro-, meso- or leptothermal?—or simply as a copper ore concentrated by the granitization of gabbro-diabasic-type rocks? Modern prospectors will find the author's ideas stimulating.

The Classification of Metalliferous Provinces and Deposits

C J. SULLIVAN

THE CLASSIFICATION of ore deposits, as given in most textbooks of the last few decades, has been based largely on assumed temperatures of deposition. That thermal zoning does occur is well attested, but to know that a deposit is hypothermal, mesothermal or leptothermal does not convey much about the value of the deposit, nor does it suggest where similar ores may be found. Significantly, the terminology is little used by today's prospectors.

By contrast, the words "native copper in basalts," "copper-nickel ores associated with basic igneous rocks," "asbestos in serpentine," "red-bed coppers," etc., immediately convey a practical meaning which corresponds with well-known field facts.

Classification of nearly all metalliferous deposits as "hydrothermal"—whether they were Sudbury nickel ores or uranium ores of the Colorado Plateau—tended to imply that all metals came from great depths, and that the local rock association had little significance except in terms of such factors as permeability, porosity, structural favorability, etc.

The accompaning table is a suggested tabulation of some types of ore deposits based on field associations. The tables are incomplete and are presented as examples only. They could easily be extended.

Although, in the view of present meager knowledge of ore-forming processes, this outline is considered as tentative, the field associations are of great practical importance and must have major genetic significance.

President, Kennco Explorations (Canada), Ltd., Toronto, Ontario. This table was presented at the Twentieth Session of the International Geological Congress, Mexico City, September 1956, and published in the *Transactions* of the Canadian Institute of Mining Engineers, Vol. LX, pp 333-335. Reproduced here with permission of the author.

REFERENCES

C. J. Sullivan, "Ore and Granitization," *Economic Geology*, Vol. 43, 1948, pp 471-490, and Vol. 44, 1949, pp 336-346.

C. J. Sullivan, "Heat and Temperature in Ore Deposition," *Economic Geology*, Vol. 52, 1957, pp 5-24.

Classification of Metalliferous Provinces and Deposits

Rock Environment	Examples	Possible Origin	Remarks
ORES DERIVED FROM SEDIMENTS			
Syngenetic Sedimentary Ores			
Beach pebble conglomerate	Rand (Au); Blind River (U)	Gravity and wave concentrated black sands rejuvenated by metamorphism	Dimensions are those of sedimentation. Concentrations of economic grade comparatively rare.
Deltaic and closed basin (euxenic) sediments. Shore-line beds. Reef facies	White Pine, Michigan; Cu belt, Rhodesia-Katanga (mostly); Mansfield	Precipitation by reduction of $CuSO_4$-bearing solutions	Deposits of great importance though economic grade rare. May in future include deposits of Ni, Zn, U, Mo(?), as well as Cu, Co known at present.
Sedimentary Ores Re-Concentrated by Circulating Meteoric Waters			
Continental and lacustrine beds. Alternating oxidizing and reducing conditions of sedimentation	Red-bed Cu ores of U.S.A. Bolivia, Nova Scotia-New Brunswick; Colorado Plateau U ores	Gradations from purely syngenetic deposits to ores which were re-concentrated by circulating waters both in ancient and in recent times	Deposits generally small and erratic. May be superficial. However, this type grades into White Pine type which has red-bed affiliations.
Banded Fe formation	Lake Superior; Labrador; most Fe ores of Lake Superior type	Re-concentration by meteoric waters from Fe-rich source rocks	It is not clear in some cases that granitization has not played a part. Where this is the case the deposits should not be superficial.
Metal Accumulations Re-Concentrated Thermally from Sediments			
Dolomitized limestone at times of algal reef origin, associated with shore lines and evaporites. Gentle folding, low-grade metamorphism	Missouri Pb; Tri-State Pb-Zn; Pine Point Pb-Zn; Zn in reefs of Alberta	Primary (biochemical ?) accumulation in limestone: re-concentration by low-temperature metamorphism over comparatively short distance	Commonly of large dimensions, perhaps reflecting comparatively low degree of re-concentration.
Limestone intruded by granite or converted to paragneiss	Pb-Zn deposits common throughout the world. Some Cu in skarn zones	Re-concentrated from limestone during granitization	Provinces co-extensive with particular lime-rich formations. Rum Jungle (Australia) U, Cu, and Pb-Zn province co-extensive with algal reef and shelf sediments.
Euxenic shales intruded by granite	Kimberley (B.C.) Pb-Zn ores associated with pyritic sediments	Re-concentrated from sediments during granitization	Sedimentary facies important in prospecting.
Carbon-rich shales and allied sediments granitized	Lake Athabaska (Canada), Rum Jungle (Australia) (in part) U provinces	Syngenetic accumulations in sediments, re-concentrated during granitization	Paragneiss may be developed (Athabaska) or homogeneous granite (Rum Jungle).
ORES DERIVED FROM TUFFS			
Tuffs and tuffaceous sediments converted in places to porphyry, granite, or paragneiss	Pb-Zn-Cu province, West Coast, Tasmania; New Brunswick Pb-Zn-Cu province; Swedish Pb-Zn ores	Accumulation of metals in tuffs concentrated during granitization	Extensive geochemical work shows widespread Pb-Zn-Cu in tuffaceous sediments, with ore concentrations associated with porphyritized tuffs. Porphyries and ores are related to structural foci.
ORES DERIVED FROM BASALTS			
Ores Concentrated During Cooling of Basalt			
Basalt, little altered; folding gentle	Coppermine province, N. W. T., Canada. Native Cu, bornite in cracks, vesicles, etc. Examples numerous throughout world	Limited concentration during cooling	Ores of limited continuity though rich in places.
Ores Derived During Metamorphism of Basalt			
Basalts considerably folded and altered, but no granite	Michigan native Cu in flow-tops and sediments intercalated with lavas	Re-mobilized from basaltic source-rock during folding and metamorphism	Deposits extensive.

Classification of Metalliferous Provinces and Deposits *(Continued)*

Rock Environment	Examples	Possible Origin	Remarks
Ores Concentrated During Granitization of Basalt			
Basalts and other lavas intruded by granite	Nicola volcanic province, British Columbia. Cu province of Chile, Peru?, Kennecott, Alaska?	Cu concentrated from volcanics during granitization	Many major provinces of this type. Very deep erosion does not favour preservation of these ores and many deposits in mountain terrains.
ORES DUE TO GRANITIZATION OF CHLORITIZED CARBONATED LAVAS (GREENSTONES)			
Chloritized carbonated greenstone belts. Lavas commonly submarine. Albite porphyry dikes, granite porphyries, and granites	Au provinces of Ontario, Quebec; Yellowknife (Canada); West Australia	Cu appears to be expelled from lavas during development of "greenstones". Au is concentrated ahead of front of granitization and "porphyritization"	Province is co-extensive with granitized greenstone belt. Au not associated with granite of same age and type intruding other source rocks.
ORES DERIVED FROM GABBRO-DIABASE			
Ores Concentrated During Cooling of Gabbro-Diabase			
Diabase dikes or sills intruding wide variety of rocks. Ores along walls	Co-Ag ores, Cobalt, Ontario; Co ores, Cloncurry, Queensland	Sulphides expelled from consolidating magma	This type of province not as productive as sedimentary ores of Rhodesia-Katanga.
Diabase dikes. Larger gabbroic masses in neighborhood. Structurally prepared rock	Cu ores of Noranda district, Quebec; Cloncurry district, Queensland; home of Bullion mine, Australia	The comparatively thin dikes associated with these deposits in time and place may be channels for movement of ores, probably derived from larger cooling gabbroic masses	Ores commonly massive sulphides, pyrite-chalcopyrite-sphalerite. This type of province is of relatively secondary importance though major deposits are found. Dikes are guides in prospecting.
Ores Concentrated by Granitization of Gabbro-Diabase			
Gabbro intruded by granite and allied rocks	Sudbury, Ontario Cu-Ni ores?; Chibougamau, Quebec?	Cu-Ni derived from norite, concentrated during replacement of norite by granite?	There are post-norite granites at Sudbury, and unfolded, unaltered gabbros are not normally productive of ore. However, Sudbury and similar areas have volcanic affiliations—pebble, dikes, breccia pipes, tuffs, etc.
As above	Bird River, Manitoba, Cu-Ni ores	As above	Ore associated with contact of gabbro and granite. The granite is the younger rock.
Dikes and sills of diabase followed by localized porphyries and granites	Ray? Globe?, San Manuel?, U.S.A.	Cu in granite and porphyry derived from digestion of diabase	Monzonite probably hybrid rock. In some cases diabase almost totally digested; in others large remnants remain in monzonite. Not all porphyry coppers are of this type. Basalt or Cu-rich sediments may also supply Cu.
ORES DERIVED FROM ULTRABASIC IGNEOUS ROCKS			
Ores Concentrated During Cooling of Ultrabasic Rocks			
Peridotite dikes and masses	New Caledonia chromite ores; Chromite ores generally; Bushveld complex Pt deposits; osmiridium deposits of Tasmania	Separation from silicates during cooling	Basic rocks not altered.
Ores Due to Alteration of Ultrabasic Plutonic Rocks			
Serpentinized peridotite	Asbestos deposits, Quebec	Constituents of peridotite recrystallized and hydrated during metamorphism and granitization	Virtually all important asbestos deposits associated with altered peridotites.
Peridotite intruded by granitic dikes	Asbestos deposits of northwest Australia	As above	In some cases, asbestos confined to peridotite near walls of granitic dikes.
Peridotite altered or replaced during granitization	Mystery Lake (Canada) Ni deposits; Lake Renzy (Canada) Ni deposits	Ni sulphides concentrated during re-heating, serpentinization, and granitization of peridotite?	Mystery Lake ore confined to serpentinized zones with paragneiss walls or occurs in paragneiss itself. Lake Renzy has a peridotite-granite association.

The Modern Mine Office—
Tools and Techniques

These seven pages contain a compilation of equipment and ideas suggested for the modern mine engineering office. They cover the wide range of mapping and drafting aids; surveying equipment by geological, geophysical and geochemical means; drilling accessories; samplers and analyzers; ground control instruments; ventilation checks; maintenance equipment; and accounting and photocopy reproduction of documents, along with training courses.

The selection of the items is not intended to be a complete representation of all available material. It is rather a guide to the varied and extremely useful tools and techniques which can speed your job and increase the economy of your operation. Addresses of the companies listed may be found in the Buyers' Directory section.

MAP RACK

Frontier Mfg Co., Dallas, Tex., introduces a handy map rack. Wire grid, in two layers, keeps rolls separated. Stepped effect of rack floor permits easy reading and separation of index labels. Comes on casters for movability.

HIGHLY SENSITIVE ALTIMETER

Fast-acting, highly sensitive (one foot at sea level) aneroid barometer has been developed for aircraft altitude control by Garrett Corp., Los Angeles.

OPTICAL TRANSIT

Many new design concepts are embodied in the Wild T-16 transit, according to Wild Heerbrugg Instruments, Inc., Port Washington, N. Y. Circles are read at a glance to one minute directly, and to 20 seconds by interpolation. A built-in repeating clamp is used for setting on zero and eliminates lower plate motions. A new optical plummet, which provides an upright image, has also been incorporated. The firm offers optional attachments, including a battery box for illumination of circle readings, horizontal and collimation level vials and telescope reticule.

ELECTRIC DISTANCE "TELLUROMETER"

Newest and most exciting tool in exploration is the Tellurometer, which replaces conventional traverse and triangulation methods used to measure distances for map making. The device, developed by T. L. Wadley with the South African Council for Scientific & Industrial Research, consists of a master and a remote station. Time required for microwave signals to travel from the master to the remote is measured and translated into distance. The tellurometer weighs only 24 lb. Operating range is up to 50 miles and the unit will function day and night, and despite many adverse weather conditions. A duplex radio-telephone permits instant voice contact between master and remote operators.

Aero Service Corp. and its subsidiaries and Hunting Aerial Surveys, as well as other aerial survey firms, make extensive use of the Tellurometer, manufactured by Tellurometer, Inc., of Washington, D.C. Photo shows an Aero Service team in the field.

SURVEYING SPADS

"Black Diamond spads have been used for two generations by thousands of mining engineers," says the Richmond, Va. manufacturer, who notes that its line of plain and non-corrosive spads are a thoroughly satisfactory and most convenient method of suspending plumb bobs, securing bearings, sighting leads, etc.

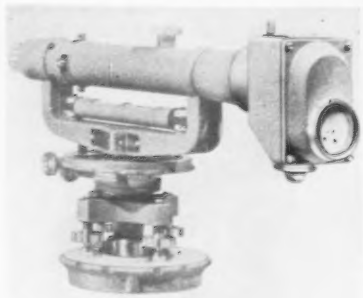
ENGINEERS TRANSIT

A 16-lb instrument (carrying case and accessories an additional nine pounds) with 11½ in. telescope, 25x power, resolving power, five seconds and a one degree, six minute field of view is offered by David White Instrument Co., Mil-

waukee, Wis. Vertical circle is 5-in. diameter, divided every 30 minutes on sterling silver; horizontal circle 6¼, also divided every 30 minutes. Accessories include plumb bob, magnifying glass, adjusting pins, waterproof cover and sunshade.

SMALL-SIZE TRANSIT

The new Berger 4½-in. RX mine transit is especially suited for making surveys in cramped and restricted areas. The instrument incorporates a newly designed optical system which provides stadia readings at greater distances. Telescope is 19-power, with coated optics and has a resolving power of 5 seconds, effective aperture of one and one-sixteenths inches and field of view of 1 deg, 26 min. Auxiliary telescope can be mounted on either side or on top for maximum flexibility. Manufacturer is C. L. Berger & Sons, Inc.



SELF LEVELING ATTACHMENT

A small and compact instrument, the new attachment is adapted to the objective end of any telescope or transit. When it is placed it is not necessary to adjust the level or transit before each sighting, according to David White Instrument Co.

SURVEYING LEVEL

Easy and fast setups and operation are reported for N-3 precision level by Wild Heerbrugg Instruments Co., Port Washington, N. Y. Bubble is observed through magnifying telescope. Accuracy stated is plus or minus 0.01 in. per mile of single levels.

NIGHT ILLUMINATED TRANSIT

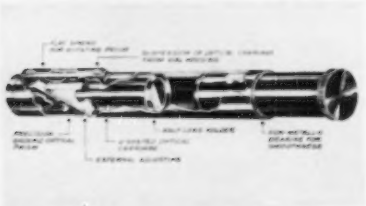
The basic engineer's transit is given a battery and lighting attachment in the Brunton Instrument Co. No. 50 NI. The model is also available with a hollow spindle for use as an optical plummet and vertical alignment instrument.

THEODOLITE WITH NEW TRIPOD

Among the features listed by Kern Instruments, Inc. for the DKM 1 small triangulation theodolite is a new type of optical micrometer. In the small triangulation theodolite, each circle has two graduations, one of which is numbered. An optical system reproduces the two graduations, one line of each appearing at the side of, and parallel to the diametrically opposite line on the other graduation. The double lines thus created are moved in the image plane with the optical micrometer so that the fixed index bisects the light gap of the double line.

DKM 1 is 20x power, 4 lb plus 2 lb for carrying case, with the centering tripod, weighs a total of 16 lb.

The centering tripod is a refinement of the tilting plate type, which 1) centers the instrument over the station point with an accuracy of 0.02 to 0.04 in.; 2) roughly levels the top of the tripod head within 2 to 3 minutes of arc; 3) offers calibration in twentieths of a foot to indicate height of instrument.



LIGHTWEIGHT HAND LEVEL

Locke-type hand level manufactured by Stratex Instrument Co., Inc. is made of aluminum, finished in synthetic corundum. No heavy brass alloys are used. Eyepiece has nonmetallic tube bearing. Cross hair is engraved on an optical glass index prism, which can be adjusted from the outside of the level with a penknife.

PORTABLE DRAFTING MACHINE

A compact drafting machine, which when combined with its drawing board can fit into a briefcase, has been announced by David Miller & Associates, Box 572, Beverly Hills, Calif. Called "Draftette," the aluminum instrument takes the place of T-square, ruler, protractor and triangles.

"PHANTOM-RULED" VELLUM

Frederick Post Co., Chicago, Ill., has introduced a new form of its Blutex vellum which eliminates the need for scaling, drawing guide lines and other routine drafting problems. By using the grid lines, the draftsman works quickly to scale. In printmaking, the grid lines disappear completely, leaving a clear, contrasting print, says Post.

PRE-PRINTED CHART MATERIALS

A complete range of chart, flowsheet and layout tapes are offered by Chart-Pak, Inc., Stamford, Conn. Kits contain lines, symbols, special templates, rectangles, bars, dotted and broken lines, as well as hundreds of other components, all printed on easily mounted tapes.

MATHEMATICAL CHARTS

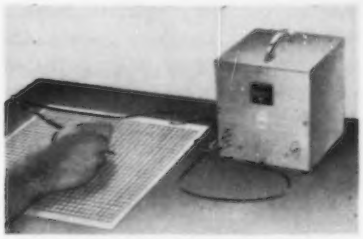
Calculine, mathematical charts are used for same purpose as a slide rule or calculating machine. Frederick Post Co., Chicago, says 8½x11-in. cards are inexpensive, use no straight edge, leave hand free, and can be placed in field notebook or under desk glass.

VERTICAL BLUEPRINT FILE

A new vertical file for single large sheets; blueprints, drawings, maps, etc., has been announced by Plan Hold Corp., South Gate, Calif. Each sheet is filed individually and hangs flat and free. A 12-in. wide file can hold up to 150 individual sheets.

MICROFILMED DRAWINGS

On-the-spot reproduction of microfilmed engineering drawings for immediate use or storage purposes can be made at low cost on a new microfilm producer-reader-enlarger machine developed by Remington Rand Div., Sperry Rand Corp. Original drawing is reduced to a 35mm negative, then inserted on an IBM-type aperture card which can be inserted into the enlarger-duplicator to produce a 17x22-in. positive print in about one minute's time.



ELECTRIC MAP CALCULATOR

An electrical instrument for determining the number of square inches, acres, miles, etc. in a given area on a map, aerial photograph or drawing, has been manufactured by Martin Kuykendall Co. Area Calculator is highly accurate, rapid, and is accompanied by tables which convert to any measurement.

SURVEYING BAROGRAPH

An altitude range of minus 1,000 ft to plus 13,000 ft is covered by the American Paulin Systems Model SMB-5 micro barograph, which also offers a chart pressure range of 1.5" merc., chart time range of 15 hours and a full line of accessories. SMB weighs 20 lb in its 7½x10½x15-in. case and is fully compensated for temperature change. Tables are provided for pressure-altitude conversion.

SEISMIC RECORDER

Recording oscillograph camera, RS-80, is designed for operation with all-frequency seismic techniques and for recording magnetic playback. It is a product of Houston Technical Laboratories.

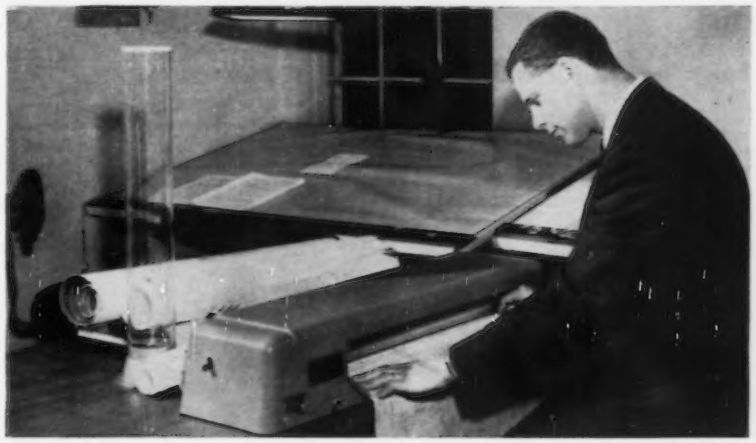
POCKET RANGE FINDER

Distances from eight to 100 ft can be measured with accuracy within 2% with the pocket-size (6-in. long) range finder, manufactured by Edmund Scientific Co.

MAGNETICS DETERMINATION

Magnetic Susceptibility Bridge MS-1 by Geophysical Specialties Co. is used for

(*Continued on p 32*)



Photocopy Machines Offer Speed, Versatility

The chore of making accurate, fast reports for distribution is being simplified by many mining firms with the use of new photocopy machines, available from a number of manufacturers.

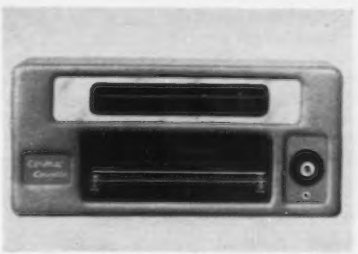
Field reports, deeds, titles, multiple survey reports and correspondence all must be circulated through many departments of mining companies, with the emphasis on speed and accuracy. The following machines offer many advantages over the old methods of re-typing or (as is often necessary) copying by hand. One, the Contoura-Portable, may even be taken into the field with a surveying team. The portable machine also offers the advantage of being able to copy from tightly-bound books.

Contoura-Portable is briefcase size, light weight. A patented air cushion permits the machine to be held face down on bound volumes, or against wall maps (see photo). Same machine can be used in the office as a regular photocopier, and to make negatives for offset printing. Both Contoura-Portable and Contoura-Matic are manufactured by F. G. Ludwig Inc., Old Saybrook, Conn.

Blu-Ray, (see top) is manufactured at Ivoryton, Conn., makes blue and black line prints from translucent originals, reproduces drawings, tracings, specs and maps. The machine is designed to accommodate low-volume print requirements and has finger-tip controls to regulate printing speeds. No special training is required for operation.

Verifax, manufactured by Eastman Kodak Co., Rochester, N. Y., makes fast copies, also can handle paper, card stock and printed office forms. Handles all types of pencil and ink writing, spirit duplicator copies.

Contoura-Matic, a desk-type machine, is 15 in. wide and six inches deep, and can be easily carried from location to location. It makes photo-exact copies on white, colored or transparent paper, film and card stock; copies blue prints, reports and charts. Any mark on any paper, including colored and black pencil, any color ink, stamps, crayon, mimeo and even spirit duplicator is reproduced clearly. The transparency can be used to make multiple copies and for projection on a screen before an audience.



Cormac Photocopy Corp., New York, calls its "Corvette" an "all-purpose machine." It also copies all inks and pencils. Machine has an 11-in. wide copying capacity.

rapid determination of magnetic properties of mineral formations. The company says the compact, 21-lb instrument can help in correlation, in checking if contrast is sufficient for using the method, and also in station spacing and instrument selection.

SOIL-TESTING KITS

Soiltest, Inc. provides a number of different concrete and soil testing aids for various applications.

GEOCHEMICAL KIT

All reagents and equipment needed for geochemical prospecting sufficient for 20 analyses are included in Geochemical Prospecting Laboratory's outfit, which can be used to test for zinc, lead or copper.

ALLUVIAL GEOCHEMISTRY

Geo-Resource Corp., Spokane, Wash., employs a new technique, called the "alluvial geochemical method," for surveying. Method is based on the principle that underground water seepage carries traces of valuable minerals into adjacent streams and gullies. Samples of alluvial soil taken from seepage areas are tested geochemically. By skillful correlation of such factors as the geologic setting, elevation and position of rock formations and underground water tables, geophysicists are able to determine the location of the deposit.

Geo-Resource, which offers its service to the industry, has already proven the success of the method and received a DMEA loan for a uranium search in the Blue Mountain area of eastern Washington.

GEOCHEMICAL WATER TESTING

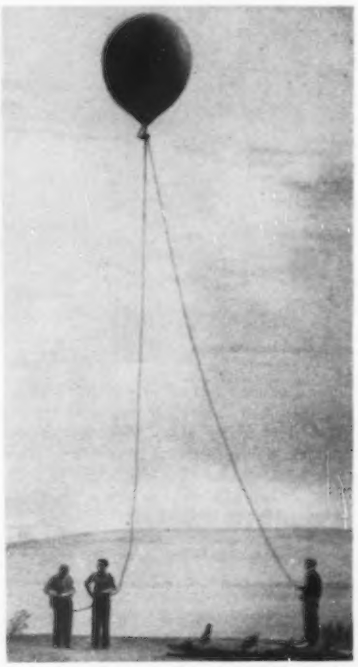
A compact field kit, about the size of a lunch basket, is being offered by Canadian Industries Ltd., Montreal, Quebec. Developed by two University of British Columbia professors, Dr. Harry V. Warren and Dr. R. E. Delavault, the process involves use of a green organic chemical, dithizone, which turns red on contact with heavy metals. The inventors say that proper reading can provide estimation of metal content in water and indicate likely prospects.

DISTORTION-FREE PHOTOS

Camera tilt and elevation distortions are eliminated from aerial photos with "orthophotoscope" announced by USGS. Projection of vertical or oblique stereopair is scanned by operator using narrow slit to produce new distortion-free negative. Scaled distances can be used with vertical angles taken in field for vertical control. Heretofore, only a map made from photos could provide accurately scaled distances.

PORTABLE SEISMOGRAPH

Newly designed portable seismograph, developed by the University of Cambridge, combines rugged and compact construction with observatory sensitivity, according to Jarrell-Ash Co. Produced by Hilger and Watts Ltd., the Watts Willmore Pattern Seismograph records for as long as 24 hours at 60mm per minute with needle-sharp definition, and is designed for a variety of geophysical uses.



PORTABLE MAGNETOMETER

The Varian M-49 "proton free precession" magnetometer, designed for use in geological-geophysical exploration, is according to Varian Associates, "portable and fully transistorized." Features which distinguish the Varian include the following: light weight, ruggedness, moisture proof, cycles manually or automatically, rechargeable batteries in polarizing power supply, extendable sensing head cable with breakaway plug. Multi-level surveying is also possible (see photo) when the sensing head is suspended from a weather balloon.

MAGNETOMETER

Permanently mounted orienting compass and 13-lb weight (including tripod) make Sharpe A-2 vertical force magnetometer a one-man instrument, says Geophysical Instrument & Supply Co., Denver.

GROUND GEOPHYSICS

Magnetic susceptibility meter, MS-160, by Mt. Sopris Instrument Corp., Boulder, Colo., can be used in field on rocks in place or in laboratory on small samples. A three-coil sensing element is employed to minimize errors on irregular rock surfaces. An aid in planning any magnetic survey.

GRAVITY SURVEY UNIT

Anomaly simulator by Houston Technical Labs aids interpreting gravity surveys. Using a light source, two dimensional silhouettes and photocell on arm, it gives shape of orebody from field data.

SELF-POTENTIAL UNIT

A one-man unit for self-potential geophysical surveying is announced by Universal Atomics Corp., New York. One model has vacuum tube voltmeter reading 0.1 mv for dry soil.

GEOPHYSICAL UNITS

Survey unit by Borden Engineering Div., M. J. Johnson Aircraft Engineering Co., Morris Plains, N.J. has Swing Current patented circuit for high sensitivity, it reports.

Resistivity survey unit by Houston Technical Laboratories, Houston, Tex., is said to have added range and accuracy. Voltmeter and generator each come in similar carrying cases.

WALKING MAGNETOMETER

According to Radiac Co., the walking magnetometer is the foot prospector's answer to the flying mag. Unit, according to the manufacturer, can be used to locate and trace magnetic and nonmagnetic anomalies, and can be operated over areas covered by muskeg, snow, water and overburden. Weight is 12 lb.

HOLE LOGGING UNIT

Tightly sealed against dust and water, radioactive logging apparatus GHL-230 for drill holes is offered by Mount Sopris Instrument Corp., Boulder, Colo. Portable in two packages, it uses a Geiger tube probe.

BOREHOLE TV

Closed circuit television for visual observation in 3-in. diameter boreholes has been developed by Dr. Leopold Mueller in Europe and is now available in the U.S. Dr. Mueller's B300 will operate to a depth of 1,000 ft, in water if necessary, and if sediment does not interfere. Camera is contained in a 2½-in. tube, which consists of a plexiglass window, eccentric mirror and miniature TV camera. A wide-angle 8mm movie camera lens gives a range of well focused clearness from the window up to 10 in.

away. On each side of the mirror three miniature bulbs provide illumination. They, and the mirror, can be remotely controlled and the bulbs controlled to get different shadow effects. Compass and spirit level readings are constantly readable on the screen, located at the surface in a Volkswagen which is built to contain electronic equipment. Cables, drums, guiding device, depthometer and winch are transported separately. Information can be obtained from Klaus John, 407 South Union Drive, Los Angeles 17, Calif.

BOREHOLE CAMERA

A 16mm camera for photographing drill holes thousands of feet down has been developed by Birdwell, Inc., of Bradford, Pa. The camera, equipped with a stroboscopic flash, is five ft long and has a 4-in. outside diameter. It is capable of taking 600 pictures in one trip.

MINIATURE GYROSCOPE

A gyro compass the size of a salt shaker, weighing less than 0.5 lb which has been developed by Minneapolis-Honeywell Regulator Co. shows promise of application in drill hole exploration. Gyro is 1.75 in. in diameter and quite capable of responding to very small turning rates, approaching the order of a thousandth part of the earth's rate. Gyro is discussed in the Seventh Annual Drilling Symposium of the University of Minnesota's Center for Continuous Study.

DRILL HOLE SURVEY KIT

A compact field pack to fit in the glove compartment of a car is available from Exploration Methods, Inc. for measuring inclination and direction of drill holes. Kit includes the Maas drill hole compass and the EMI goniometer and other essentials. The compass operates on the gelatine principle, which locks the compass needle in place after it has reached the selected testing depth. Hydrofluoric acid etches the glass container to give inclination. Non-magnetic clinometer cases and drill rods are available to test holes from EX to NX size. Larger holes, too, can be surveyed with special equipment.

MULTIPLIER PHOTOTUBE

Ultra compactness of ¾-in dia ten-stage multiplier phototube by Allen B. Dumont Laboratories, Inc., Clifton, N.J., is claimed a boon to drill hole probing. In the past, comparable tubes were of considerably larger diameter.

LIGHTWEIGHT FLUORIMETER

Mt. Sopris Model FL-210 is intended for analyzing uranium minerals and for use in geophysical prospecting, in laboratory and field.

ORE ANALYZER

Neutron Adsorption Analyzer by Reed-Curtis Nuclear Industries, Inc., Los Angeles, selectively detects and measures percent of elements having high adsorption cross section present in sample. Rare earths and precious metals are among the elements that are said to be quickly measured without the need for chemical treatment.

MULTI-ELEMENT SPECTROGRAPH

Autrometer, multi-element indexing X-ray spectrograph analyzes as many as 24 separate elements in a given specimen. North American Phillips Co. Inc. also notes that the console desk-type unit incorporates several automatic features.

Th-U ORE ANALYZER

Determination of uranium and thorium amounts in ores is possible with an analyzing unit manufactured by Tracerlab, Inc. Scintillation counter and geiger tube are mounted in a well.

SPECTROGRAPHIC AID

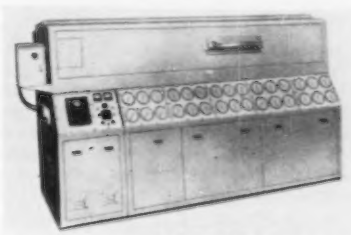
Irregularly shaped samples are analyzed more easily in spectrum analysis with the Petry stand, made by Bausch & Lomb. Sample is placed on platform stage and an electrode placed beneath it. Process merely leaves a charred spot on the metal surface. Device is simple, designed to clamp on illuminating bed of current B&L spectrographs.

LABORATORY CYCLONES

Set of 15 and 30mm Pyrex hydroclones, each complete with a range of interchangeable vortex finders and apex nozzles fitting by means of ground glass joints, are made by Liquid-Solid Separations, Ltd., London, England. Test set has capacity of about four gpm at 40 psi feed and can make separations to 5 to 10 microns.

INFRA-RED ANALYZER

Designed for instantaneous analysis of flowing chemicals with an accuracy duplicated only by chemists in lengthy laboratory methods, this new model can provide quick and accurate answers on a single component in a simple or complex gas or liquid stream. According to Mine Safety Appliances Co., Model LIRA 200 can give an answer in less than 30 seconds.



VERSATILE SPECTROMETER

Complete analysis of both ferrous and nonferrous metals and alloys is available in 30 seconds with the new direct reading spectrometer developed by Jarrell-Ash Co., Newtonville, Mass. Instrument features include: Simple, fingertip control of all operations, workability by non-expert operator, safety-interlocked circuits, easily serviced plug-in components. Design permits optional film recording of the analytical spectrum.

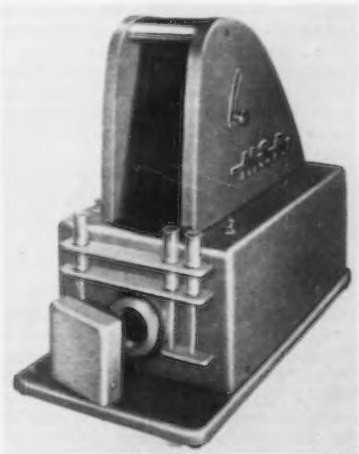
COMPUTER SPECTROMETER

"The first unit of its kind to present information capable of being fed directly into electronic computers" is the claim made by Baird-Atomic, Inc., Cambridge, Mass. for its new direct reading spectrometer, developed for the National Bureau of Standards. The reader is equipped with an automatic glow tube readout system, and with the computer, can perform 1,080 determinations with complete data processing in about two hours.

SPECTROGRAPH

Automatic Spectro-Lecteur, developed by International Electronics Corp., Mineola, N. Y., can determine six elements in an alloy in less than one minute. Lecteur, called the first direct reading spectrograph, uses two photomultipliers instead of a photographic plate to measure spectrum emission lines. Photomultipliers eliminate integration. And the company reports that any number of elements can be posted on the program ruler.

In the direct reading method, results are recorded automatically on a chart as the moving multiplier goes from station to station on the ruler. Lecteur operates as follows: prepared sample is mounted on the exciter and the start button pushed. The moving multiplier then goes from station to station as determined by the stop buttons on the ruler. Analysis is made through the electrical measurements taken from the condensers loaded by the photomultipliers.



MICRON MEASUREMENT

Mine Safety Appliances Co.'s particle size analyzer was designed to take particles in the 0.1 to 40 micron range. Sample is first centrifuged and then measured to determine particle size distribution.

SPECTROMETER

Low-cost grating type scanning spectrometer with better dispersion and resolution than conventional units is announced

by Jarrell-Ash Co., Newtonville, Mass., who also claim that the compact table unit is ideal for trace element analysis.

SPECTROMETER

Beck Spectrometer No. 3505 reads wavelengths directly in angstroms on a graduated drum to 1A. Aligning the same bands of two readily visible reversed spectra gives quick, accurate reading. Ealing Corp., Natick, Mass.

MICROBALANCE FOR SAMPLES

You can weigh small samples much more easily, quickly and accurately with the Cahn Electrobalance, according to Cahn Instrument Corp. Gravimetric analyses may become much more effective with this improved device, says the firm, and less skilled operators can operate it. Balance is in wide use in Canada, where instrument analysis is frequently made so sensitively that it is performed with milligram samples.

Measurements are obtained by balancing the electrical force set up by the sample weight against a potentiometer and a galvanometer, then the voltage is measured and converted to true sample weight. Since the balance is calibrated with a known mass, measurements are in true mass units, independent of the local force of gravity. On 0 to 5 mg samples, sensitivity is one microgram; accuracy is 2.5 micrograms. On 0 to 50 mg samples, sensitivity is eight micrograms, accuracy is 30.

SAMPLE SPLITTER

Three models of Carpco Mfg. Co.'s sample splitter are available, says the company. Splitter has a top hopper with bottom discharge slot and cut-off gate. When the gate is tripped, sample falls like a curtain over accurately spaced stainless steel blades. Collecting pans are of aluminum alloy design.

PARTICLE SIZE DISTRIBUTION

Originally developed to count blood cells, the Coulter Counter, offered by Coulter Industrial Sales Co., counts and measures the size of particles in a fluid suspension by forcing the fluid through an aperture having an electrode on each side.

As particles pass, aperture resistance changes in proportion to the particle size and the resultant electrical impulses are recorded and counted. In Model A, particle frequency vs particle size is obtained directly.

A ten point particle count and size distribution requires only about five to ten minutes. Standard apertures available cover the 2- to 70-micron range, while special units are available for reading below one micron and upwards of 100.

FOR PRECISE SIZE ANALYSIS

Sharples Corp. designed the Micromerograph particle distribution analyzer to take the guesswork out of laboratory determinations. Instrument records time and weight of a given particle size as it falls down a loading chamber to a balance pan below. Data is recorded on chart so that size percentages can be picked off with a template.

MICROSEISMIC DETECTOR

F. J. Crandell, vice president and chief engineer of Liberty Mutual Insurance Co., Boston, Mass., and members of his staff developed the microseismic detector for discovering likelihood and frequency of falls of rock, combined with a system for monitoring rock to determine likely failure time.

Instrument consists of a sensitive geophone for sub-audible squeaks, cracks and rumbles and earphones. System was described in full detail in *E&MJ*, December 1955.

Biggest problem in using the detector is the necessary training of the operator to discern between outside noises and the noises of rock movement.

EXPLORATION SEISMOGRAPH

Model MD-1 refraction seismograph can be used for determining depth of bedrock, presence or absence of bedrock or solid material at any depth to 50 ft, according to Geophysical Specialties.

AIR SAMPLER

Fixt-Flo is a compact air sampler designed to collect relatively large samples of airborne contaminants on filters for analysis. Mine Safety Appliances, Pittsburgh, says automatic flow control as filter loads up maintains exact volume.

BAROMETER FOR SURVEYING

The model PMB-2 micro barometer, which American Paulin System, Los Angeles, calls the "Miner," has a range of 28.80 to 31.00" of mercury, with graduations at 0.001". In a leather case, the barometer weighs 1¼ lb, is 8x4½-in. Recent USBM activity with barometers in underground ventilation surveying is discussed in Information Circular 7809.

CURVE CALCULATOR

Equameter is an electric analog computer for finding equation of curves. It is reported inexpensive, provides direct readings and is simple to operate. Gerber Scientific Instrument Co., Hartford, Conn., is the manufacturer.

CO ATMOSPHERE TESTER

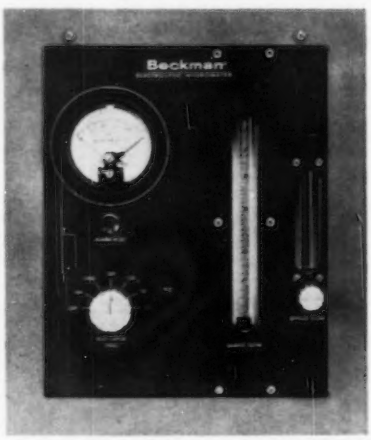
A low-cost, dual-purpose carbon monoxide tester, which can detect CO concentrations right in the engine exhaust as well as in room atmospheres is being marketed by Oxy-Catalyst, Wayne, Pa. The direct reading unit shows concentration levels and indicates the approximate percentage concentration. The detector kit consists of a pushbutton aspirator pump with a connector for holding the detector tube; 24 replaceable sealed glass detector tubes containing the yellow, chemical-gel detector; and six rubber caps. Length of discolored portion in the tube shows concentration.

RADON GAS SAMPLER

Utah Juno, radon gas survey unit, has been designed to meet safety regulations of Utah Industrial Commission aimed at safeguarding health of uranium miners. Developed by Atomic Engineering Corp., Grand Junction, Colo., the counter is easily handled while taking air samples in checking for adequate ventilation.

FAST GAS INDICATOR

Change in resistance of platinum filament, due to heat of oxidation, measures combustibles in air sample sucked into flashlight-battery powered device of Mines Safety Appliances Co., Pittsburgh.



PANEL-MOUNTED HYGROMETER

Beckman Instruments, Inc., panel-mounted electrolytic hygrometer automatically and continuously measures water concentrations in vapor samples with a 5% accuracy in the 0 to 1,000 parts per million range in temperatures up to 100 deg C.

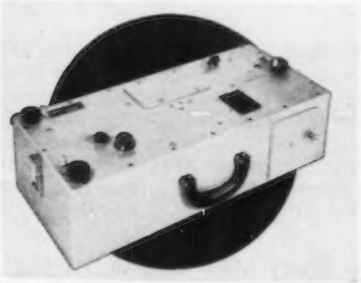
SEISMOGRAPH

Seismolog is compact portable seismograph for recording industrial vibrations from blasting, etc. Developed by Vibration Measurement Engineers, Chicago, unit gives photographic record and needs no specially trained operator. Key to great portability is lightweight power pack by General Dry Batteries, Inc. of Cleveland, Ohio.

BLASTING SWITCH

Positive and short timing for seismic work is offered on blasting battery switch called Short Pulse Blaster by

Houston Technical Laboratories, Houston Tex. There is a compact carrying case.



PORTABLE SEISMOGRAPH

The latest design features are included in the new portable blast and vibration seismograph, manufactured by W. F. Sprengnether Instrument Co. Instrument monitors vibrations and provides a permanent record; can be operated without technical training. No external power sources are required for the 38 lb machine.

NOISE ANALYZER

Noise abatement programs will be aided by Soundscope, says Mines Safety Appliances Co., Pittsburgh. Self-contained 20-lb electric unit replaces four units formerly required to properly analyze intensity and frequency.

X-RAY INSPECTION UNIT

Designed for rapid inspection of structural members, pipes, welds, et al, portable MG 260H x-ray radiography unit fits into the trunk of an auto. It is made by North American Philips Co., Inc., Mt. Vernon, N. Y. and can operate from 110, 120, or 440v ac power supply. Instrument is waterproofed for outdoor use.

VEHICLE TACHOGRAPH

Vehicle operation is recorded in chart form to provide a permanent and accurate record for uninterrupted periods up to seven days of speed, mileage and time moving and stopped, on the VDO tachograph, manufactured by VDO Instrument Co., of Frankfurt, Germany and available through Engler Instrument Co., Jersey City, N. J.

RECORDING TACHOMETER

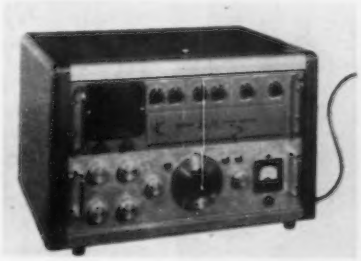
General Electric Co. has developed a recorder that measures and records speed with an accuracy of plus or minus 0.1% of measured speed. Designed for GE's dc tachometer generators, the device can be calibrated in rpm, fpm, or similar units to measure speed on many industrial machines.

CABLE FAULT LOCATOR

A simple, light cable fault locator designed to pinpoint short and open circuits in trailing cables having two or more conductors, has been announced by Ohio Brass Co., Mansfield, Ohio. Instrument is carried in a canvas shoulder bag, with attached signal probe (about the size of a flashlight) held along the cable. Battery and signal generator are attached to power end of cable.

VIBRATION ANALYZER

A new three-in-one instrument, the IRD Model 311, offers vibration analysis, a portable in-place balancer and a system to monitor vibrations in machinery, is being manufactured by International Research and Development Corp., Worthington, Ohio. Machine can be used on machine tools, motors, power transmission systems, blowers, pumps, fans, generators, etc. to trace and reduce wear, poor performance and machine chatter.



ENGINE INDICATOR-ANALYZER

All internal combustion engine pressures, vibrations and ignition voltages can be measured directly with the new SLM indicator-analyzer, Series EA-114, according to Kistler Instrument Corp., North Tonawanda, N. Y. A Swiss-made quartz crystal pickup, when used with various adaptors, shows vital engine functions on an oscilloscope screen. Cylinder, manifold, fuel injection and detonation pressures, combustion pressure rates, engine vibrations and crankshaft torsional vibration, can all be measured.

TRUCK TESTING INSTRUMENTS

Engine and electrical system tester, manufactured by Snap-On Tools Corp. requires no outside 110v power, can be used anywhere.

Engine indicator analyzes internal combustion pressures, vibrations and voltage. —Kistler Instrument Corp.

Instrument to measure depth of tire tread has been developed by Dill Manufacturing Co.

PAYROLL TAX COMPUTER

Calcu-Tax is a device designed to cut time required to prepare weekly payroll statements. It shows withholding tax and new Social Security tax, for wages up to $250 per week. Replacements are available as tax rates are changed says Calcu-Tax Corp.

MODERN COMPUTER

With the help of a modern computer, a consulting engineer produced a report in four hours that formerly took four or five weeks to complete. Royal McBee Corp., Port Chester, N. Y., now offers the LGP-30, which it considers the latest in compact, mobile, efficient and reliable computers. The computer has a 4096 memory drum capacity, access time per instruction of 2 ms to 17 ms. Machines can be purchased or rented from Royal McBee, who will also train personnel.

TRUCK TRAINING

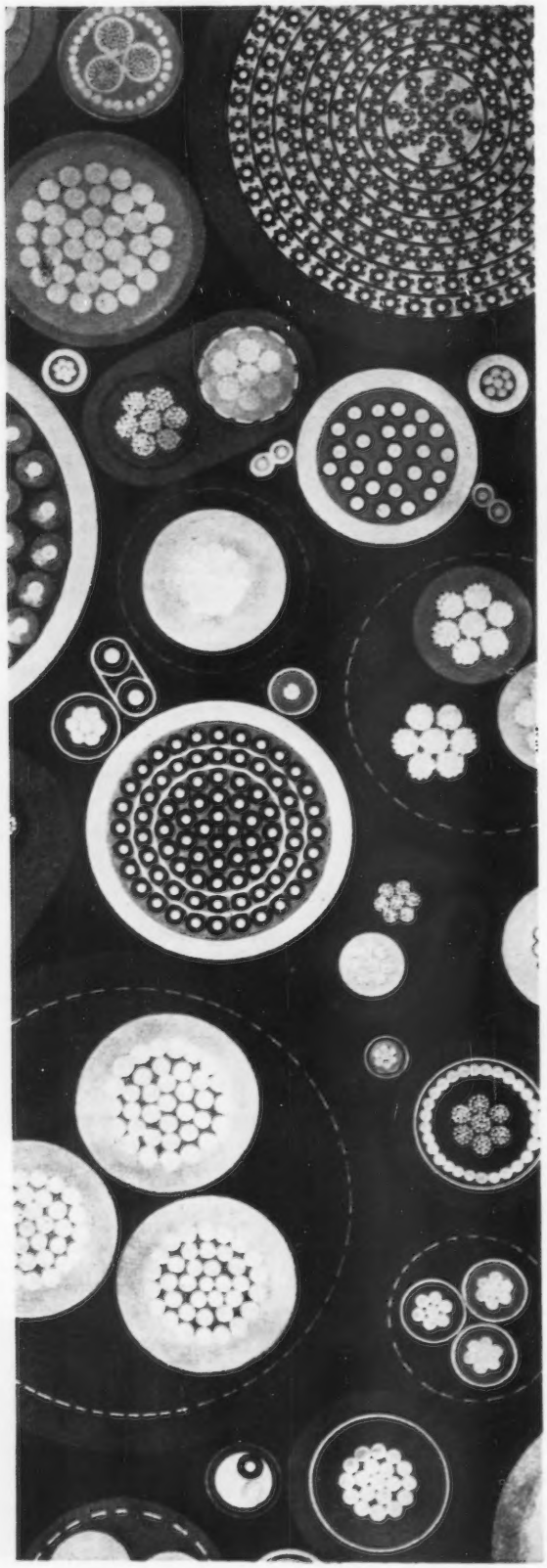
Free training courses for General Motors Corp. trucks and latest servicing techniques has turned out more than 10,000 skilled truck maintenance specialists. Owners of GMC equipment can learn more about the free courses from the company direct.

RESEARCH CENTER SERVICES

Studies and analyses ranging from single tests to long-range research will be made available to all companies on an actual-cost basis at Kennedy-Van Saun Manufacturing Co.'s new research station at Danville, Pa. Company has constructed a pilot plant and analytical laboratory. Equipment is available for crushing, grinding, ore dressing and chemical processing.

SERVICE TRAINING

Euclid Div. of General Motors maintains a service training team which operates schools for mine maintenance crews. At Babbitt, Minn., the Euclid team conducted a two-week course which combined theory sessions and practical work sessions on the complex systems of Euclid trucks. Films and cutaway truck components are part of the course.



Power Cables

MINE PRODUCTION depends upon five elements: Men, machines, power, methods and management. One of the most critical of these five is power, because all production stops when that fails. This section of the Guidebook covers two important aspects of power—conductors for the efficient transmission of power from the source to the working face, and circuits which will safeguard men and equipment.

Why Study Mine Cables

Safety. It is estimated that trailing cable operating under conditions of severe mechanical abuse is responsible for slightly more than one-third of electrical accidents in mining operations.[1] Consequently, cable design engineers have made a major effort to improve the construction of mine cables to withstand the rugged abuse to which they must be subjected. One of the principle worries of mine operators is the possibility that electric current at high voltages may become short-circuited within a piece of equipment and injure an employee who might happen to come in contact with the frame of the unit. This hazard exists in improperly protected equipment underground and on the surface. Mine electricians, equipment manufacturers, and cable manufacturers have cooperated to minimize this hazard.

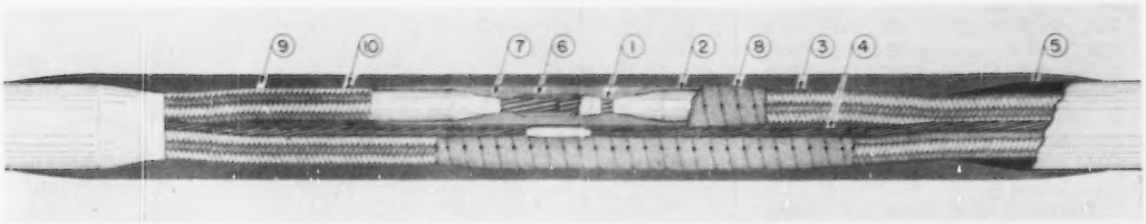
Two aspects of the problem are covered in this section: (1) The design of mine cables with proper insulation, conductors, and "ground" wires which will facilitate the shutdown of an electrical circuit when a fault or short circuit occurs in a piece of electrical equipment, and (2) mine circuits and controls which will react instantly to protect men and equipment when dangerous currents break through insulation and leak into metal frames or other parts of machines accessible to mine workers.

Efficient power transmission. If you ask any experienced master electrician about his major problems, he will invariably reply that no matter how adequately he plans his power circuits, the production staff will always manage to hook on more equipment than anticipated and overload the circuits. This has several very serious disadvantages which every operator should consider: (1) In overloaded circuits, the voltage drops, and the amperage goes up. Rise in amperage means more heating—actually heating increases with the square of the amperage. In the following pages on cable design, you will note that the designers stress the importance of temperature conditions; (2) When voltage drops, machines slow down, and you simply are not getting 100% production out of the high-priced operators running the machines. The solution to the problem boils down to this:

1. Apply a generous factor of safety when you estimate the number of equipment units and the power required to run a mine section.
2. Provide power-transmission and control systems that will be more than adequate. It's almost a certainty that you will run into an unexpected water flow, or a serious ventilation problem, or some other condition that will force you to "hook on" more equipment than planned.
3. Get acquainted with many special types of cables and conductors provided by manufacturers to do the job safely and efficiently.

◀CABLE DESIGNS from booklet on "Electrical Wires and Cables," published by Kaiser Aluminum & Chemical Sales, Inc.[8]

—Key to Safe and Steady Production



① **Conductor**
② **Conductor Insulation**
③ **Conductor shield**
④ **Grounding conductor**
⑤ **Neoprene Jacket**
⑥ **Connector**
⑦ **Vulcanized splice-insulation**
⑧ **Copper-mesh shielding tape**
⑨ **Vulcanized splice-jacket**
⑩ **Spot solder**

LONGITUDINAL SECTION through this spliced power cable for 5,000-v, ac power shovels shows the important materials used in cable construction: conductors, insulation, and reinforced covering. See photograph of same cable below.

How to Select Cables

The following sequence of steps is recommended as a guide in the selection of mine cables and conductors[2]:

1. Determine installation and operating conditions:

a. Load, voltage, frequency, power factor, neutral grounded or ungrounded.

b. To be installed in conduit in free air, encased in concrete in underground ducts, direct burial, aerially or submarine.

c. Ambient temperature of air or earth.

d. To be installed singly or as one of a group; conduits separated or grouped together; if in ducts, number and make-up of bank, number of loaded cables.

e. Load factor.

f. Special conditions.

2. Select the insulation.

3. Number and type of conductors. (See types of conductors and their application.)

4. Select the covering.

5. Select conductor size.

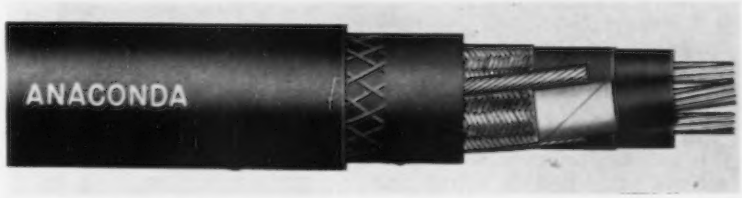
6. Check the current rating of your installation.

7. Check National Electrical Code regulations. See whether conductor is large enough to meet code requirements.

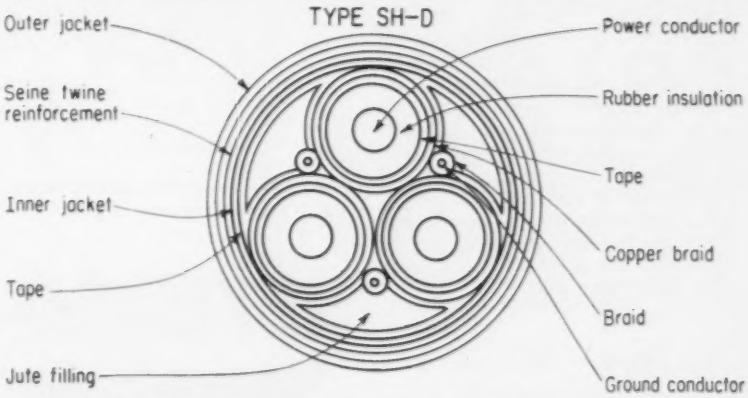
8. Check current rating for voltage regulation.

The above illustrations are presented to give the reader some idea of the common parts of cables and the names of these parts. The SH-D cable designed for ac service and high voltages is one of a family of four shielded, three-wire cables, so designated by the Insulated Power Cable Engineers Association. IPCEA specifications and National Electrical Code (NEC) ratings are used in manufacturers' literature to assure the cable buyer of performance and reliability when he selects a certain type or brand. Following sections of this article cover the various materials used in cable manufacture, and special types for various mine applications. Useful tables to guide in cable selection are also included.

Note: All references indicated in captions and in the text are listed at the end of this section.



EACH ELEMENT of a power cable including conductors, ground wire, sheathing, insulation must be designed to meet operating conditions listed at left. Type SH-D.[5]



CROSS SECTION of a standard cable for mine and open pit power equipment identifies the important materials and parts used in construction of cable. Simplex SH-D.[1]

Conductor Selection

Principle factors to be considered in the selection of conductors in cables are:

1. Materials
2. Flexibility
3. Shape
4. Size

Materials used in conductors in-

clude: (1) Copper, which is generally annealed for insulated wires and cables, or medium-hard drawn when used in vertical suspension where tension is applied to the cable, (2) aluminum for some applications using larger than No. 6 AWG (American Wire Gage) conductors, and for installation requiring long aerial suspension or direct burial, and (3) bronze wires for certain trolley applications.

Flexibility and shape are closely related, and wire manufacturers offer a wide variety of shapes or combinations of shapes to fit various specific needs. See illustrations at top of page for examples of shapes used in commerical cable manufacturer.

Size and number of conductors are determined by two considerations: (1) Voltage drop, which is determined by conventional methods and which is a limiting factor only for small conductors and low voltages; and (2) temperature, the limitations of which are dependent upon the type of insulation.

To calculate the size of conductors it is necessary to determine the present and future load, its average and daily maximum value, the required voltage and permissible voltage drop, the type of circuit (i.e., dc, ac, single- or multiple-phase) and the temperature of the surrounding medium. Other important factors are: the thermal characteristics of the insulation and cable coverings, location of the installation, (i.e., aerial, underground, or within ducts), the proximity of other cables carrying current and the number of such adjacent cables. Space limitations in some installations also command attention in the choice of the size and number of conductors for a cable. Anaconda[2].

Selecting Insulation

Factors to be considered in the selection of insulation are:

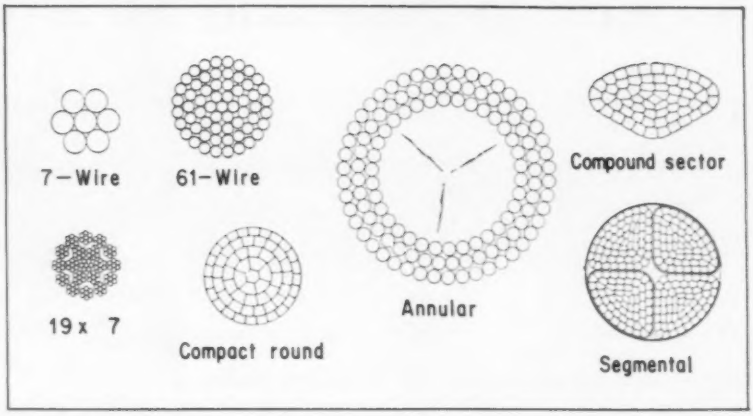
1. Voltage rating
2. Amount of load to be carried
3. Length of circuit
4. Type of installation
5. Economy
6. Operating conditions

Cable designers point out that there is a limit to the electrical stress (dependent upon voltage) which insulations or insulating compounds can withstand. No wire or cable will operate indefinitely at higher stresses than those for which it is designed. Since the universal insulation material suitable for all installations has not yet been invented, a selection must be made from the numerous types of insulation now available.

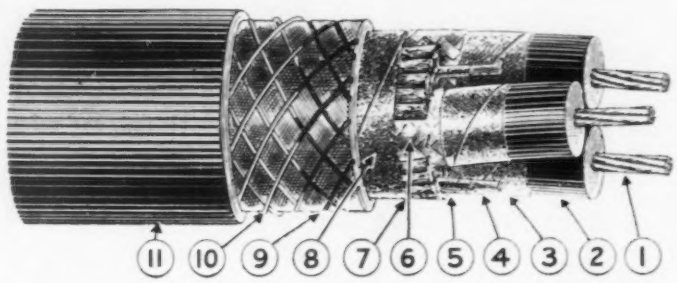
Insulations are classified broadly as follows, according to material used in construction:

Thermoplastics. These are usually compounds of vinyl resins and other materials. They have a high dielectric loss; are highly resistant to moisture, ozone, most chemicals and oil; are usually used without braids and other covering material; are available in many colors; are flame resistant; can be applied in thin coatings because they are so effective, and are easily spliced and terminated. They are used in building wire, machine tool wiring telephone circuits, and appliances and controls.

Thermosetting. Buna-S, a synthetic rubber, and also natural and butyl rubber, are now used in producing insulating compounds. The insulation is compounded, milled, extruded and

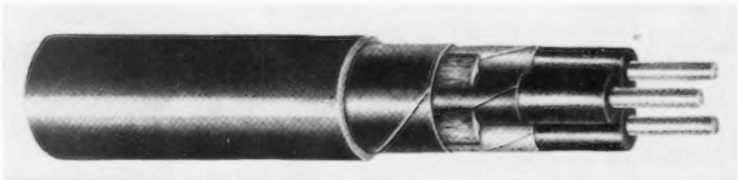


CONDUCTOR SHAPES are designed to give varying degrees of flexibility or compactness. Shown above are multiple and stranded round shapes, compact round, compact sector annular and segmental. Segmental conductors are used only for single-conductor cables of high-current capacity. Segmental conductors have ac resistance lower than concentric stranded conductors. Annular conductors are used for 500 amp or above. Selection of special shapes requires expert advice. Anaconda[2]

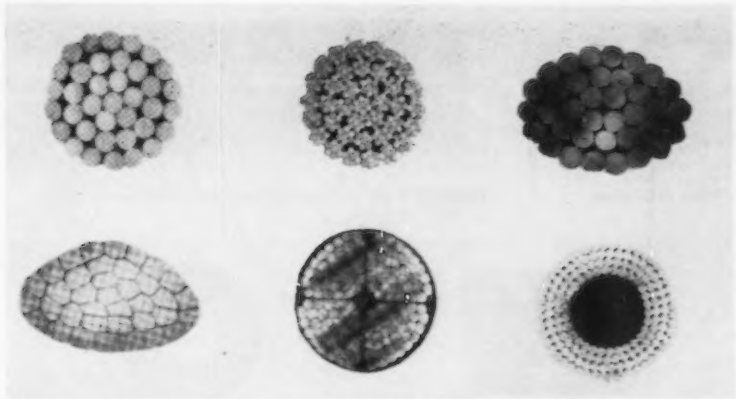


1. Power Conductor
2. Rubber Insulation
3. Tape
4. Ground Conductor
5. Braid
6. Copper Braid
7. Jute Filling
8. Tape
9. Inner Jacket
10. Seine Twine Reinforcement
11. Outer Jacket

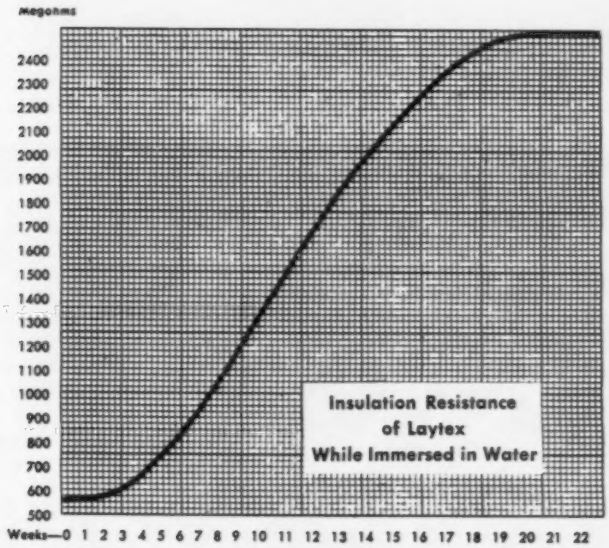
PORTABLE RUBBER-COVERED power cable shows complexity of insulation, reinforcing elements and jacketing required for rugged use. Simplex, Type SH-D.[5]



INSULATED WIRES are covered with shielding tapes, strengthened with jute fibers, and enclosed in reinforced dual neoprene sheath. Circle Wire & Cable.[7]



CONCENTRIC CONDUCTOR (top left) is for most types of general usage cables; rope stranded (top center) designed for extreme flexibility; normal sector (top right) reduces diameter and cuts down weight; compact conductor (lower left) is smoother and smaller than round or normal sector; segmental conductor permits heavier loads for same copper area; annular (rope core) conductor (lower right) is for heavy current loads in transformers and generators. Okonite[4].



LATEX INSULATION designed for use in moist locations shows increased resistance when immersed in water. Note immersion time. Kaiser Aluminum.[6]

vulcanized in most cases. Thermosetting insulations have a lower dielectric loss than thermoplastics; are not as susceptible to sunlight and ozone attacks as natural rubber; are superior to natural rubber in resisting oils, chemicals and moisture; are more flexible than thermoplastics at low temperatures; and are easily spliced and terminated. Synthetic rubbers are used in building wire, flexible cords, fixture wire and telephone wire.

Asbestos and asbestos varnished cambric. These withstand high temperatures, have a high dielectric loss, and are affected by moisture unless covered with lead or impervious sheath.

Varnished cambric. This type is applied in the form of a tape. A lubricating compound is used between tapes. Varnished-cambric insulations have a low dielectric loss; do not require a lead sheath except in wet locations; are adapted to use on large conductor sizes, are adapted to long vertical runs, and are comparatively easy to splice and terminate.

Impregnated-paper cable (solid type). Impregnated-paper insulation is applied in the form of thin tapes. The taped cable is vacuum-dried to remove all moisture, and then impregnated with oil, then lead covered. Impregnated-paper insulation has a high dielectric strength and low dielectric loss, does not require a lead sheath; is not adapted to long vertical runs without armoring, requires care in splicing and terminating, and is less expensive than varnished-cambric or rubber, lead-covered types. This type is adopted by practically all utility companies for underground transmission and distribution service because of its high current-carrying capacity, reliability, small diameter and economy. Anaconda [2].

Selecting the Covering

Protective coverings applied to cables and conductors include the following:

1. Cotton tape and braid.

2. Mica-coated pitch and asphalt. A coating of mica flake or other finely-divided dry material is applied over all.

3. Smooth black coverings for use where a hard finish is required. The saturant is usually a pitch or asphalt. The finish is an asphalt base compound with black wax. Rubber-insulated building wire up to 600 v is supplied with a moisture-resistant and flame-retardant smooth, black finish.

4. Paint-filled and finished coverings usually are supplied for use where high resistance to heat and flame is desired.

5. Lead sheath may be used in clean, dry or moist ducts where the cable is not subjected to mechanical injury or liable to corrosion. A protective covering should be used over the lead sheath for corrosion protection in wet ducts, mines or other places for burying directly into clean earth.

6. Arsenic-lead alloy. This type has high resistance to bending fatigue, low creep rate, high bursting strength, superior welds, non-age-hardening characteristics, high resistance to stress cracking, and exceptional toughness combined with hardness and strength.

Protective coverings may be applied over lead sheath to minimize sheath losses by insulating sheath from ground, to protect against unusually abrasive conditions, and to protect against corrosion in ducts or in air.

7. Jackets. Neoprene or all-rubber jacketed cables are used where maximum flexibility, high resistance to abrasion and moisture are required. Applications include portable cables for mining equipment, power shovels,

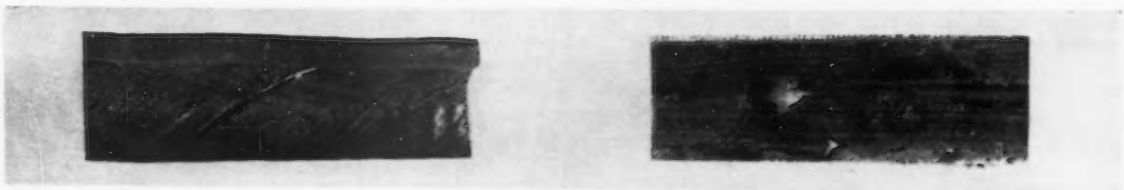
LOOSE NEOPRENE jacket that failed to bond insulation.

POROSITY of insulation resulting from overheating.

INTRUSION of neoprene in insulation.

VOID caused by damage to insulation.

AIR BUBBLE discovered in insulation.



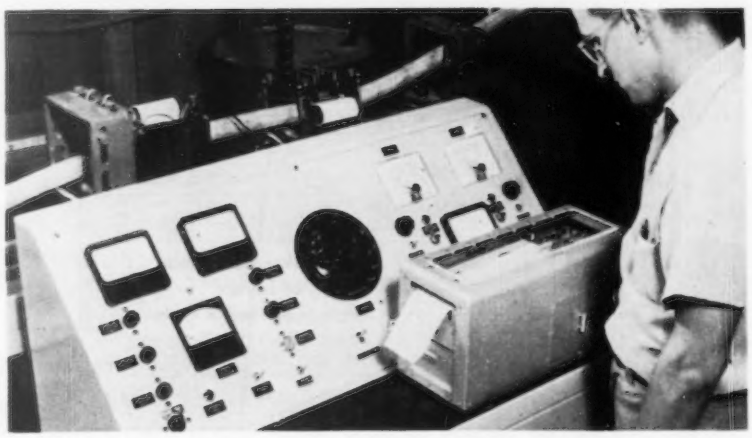
VOID IN INSULATION caused by non-lapped tape.

BUBBLE caused by drop of water or oil which vaporized.

dredges and portable tools. Normally these jackets are made of neoprene where sunlight and exposure to petroleum products are encountered, for direct burial in earth, or where flame, impact and abrasion resistance are required.

Thermoplastic jackets are applied to cables where a tough abrasion-resistant, moisture-resistant and extremely corrosion-resistant material is required and additional cost can be justified.

8. Armors. These are applied to leaded cables to protect the lead from damage, and to non-leaded cables to protect against mechanical injury. Types include round-wire, steel-tape, interlocked steel-tape, braided-wire, nonmagnetic and nonmetallic armors.



CABLE TESTING UNIT at Okonite plant checks uniformity of gage, reveals insulation flaws with ozone test, and explores extent of flaws with X rays. Photographs at top of page show some of the flaws exposed by testing unit.

Importance of Shielding

Conducting shields are placed over insulation in high-voltage applications to protect cable insulation continuously, to increase safety to human life, and to protect insulation against electrostatic stress.

In a shielded cable, a conducting tape, usually metallic, is placed immediately over the insulation around each conductor so that every point on the surface of the insulation is substantially at ground potential. A similar tape may also be place over the assembled conductors.

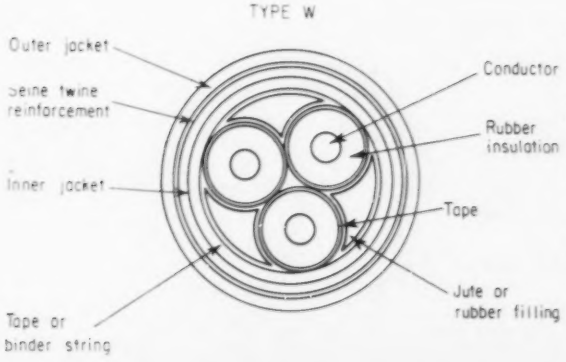
Shielded cable is used for high-voltage systems and is not usually important in systems operating at the lower 600- to 2,300-v level.

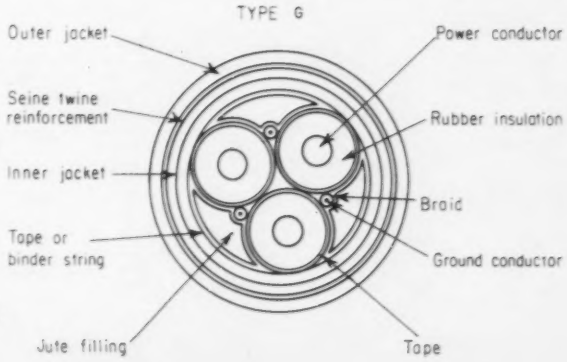
Where shielded cables are installed, the metallic shielding must be solidly grounded. Where conductors are individually shielded, each must have its shielding grounded, and the shielding of each conductor should be carried across every joint to assure positive continuity of a shielding from one end of the cable to the other. Where ground conductors are part of the cable assembly, they must be connected with the shielding at both ends of the cable.

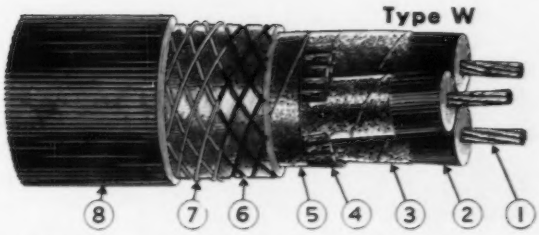
Summing It Up

In this brief coverage of cables and conductors it is evident that the selection of the type to be used for a particular job is a complex process in which the help of the cable-design engineer and the manufacturer will prove

Types of power cables

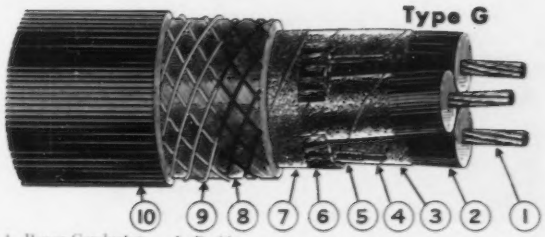






1. Conductor
2. Rubber Insulation
3. Tape
4. Jute Filling
5. Tape or Binder String
6. Inner Jacket
7. Seine Twine Reinforcement
8. Outer Jacket

TYPE W CABLE for power transmission contains no shielding or ground wires. Applications are limited. Simplex, Type. W.



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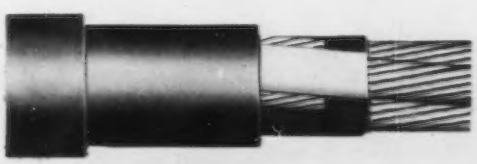
4. Ground Conductor
5. Braid
6. Jute Filling
7. Tape or Binder String
8. Inner Jacket
9. Seine Twine Reinforcement
10. Outer Jacket

TYPE G contains no shielding, but has ground wires suitable for protective circuits for moving machines. Simplex, Type G

TYPE W portable cable for moving equipment in surface and underground mines. Size, 600-v. Anaconda, Securityflex.



TYPE G, portable, neoprene-jacketed cables for moving mine equipment. Size, 600-v. Anaconda, Securityflex.

invaluable. The metal conductors can vary in size, shape, material and construction depending on whether the job calls for ac or dc current, single or multi-phase circuits, high or low voltage, rugged portable use or installation in conduits, grounded or ungrounded circuits, exposure to corrosive or abrasive conditions, etc. The insulation selected will be equally dependent upon the foregoing conditions.

Cable makers, recognizing the vital role of conductors in the power and production aspects of modern industry, take great precautions to check the quality of components which go into a cable, and in the performance of the assembled products. Tests are made to determine insulation quality by immersing the cables in water for long periods. In a recent description of the cable testing facilities at Okonite Co., mention was made of the "Gooding Test Train" employed to check uniformity of gage continuously, establish ionization recordings for each foot of cable to reveal flaws, and to determine the extent of the flaws with an X-ray machine. Types of flaws revealed by this train are illustrated.

Portable Mine Power Cables

Insulated, portable power cables constitute one of the most widely used families of conductors in the mining industry. These portable cables are used in draglines, power shovels, dredges, large-hole drills, shuttle cars, mine conveyor equipment, mine locomotives, and other track-mounted, rubber-tire-mounted, or tractor-mounted equipment. These types of portable cables have been classified as follows by the Insulated Power Cable Engineers Association (IPCEA):

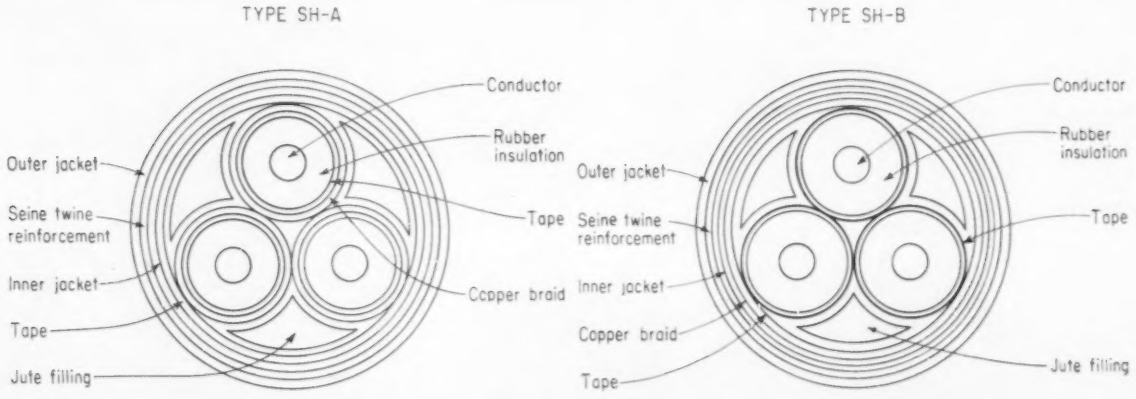
Type W. Two-, three- or four-conductor power cable, nonshielded, without grounding conductors.

Type G. Three- or four-conductor power cable, nonshielded, with grounding conductors.

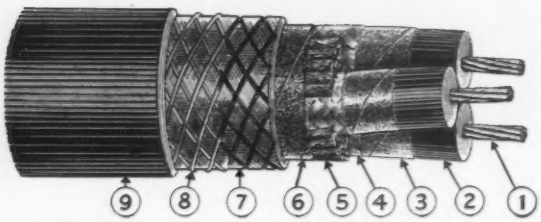
Type SH-A. Three- or four-conductor power cables with shield on individual conductors.

Type SH-B. Three- or four-conductor power cable with shield over assembly of conductors.

Type SH-C. Three- or four-conductor power cable with shield over the assembly, and with grounding conductors.



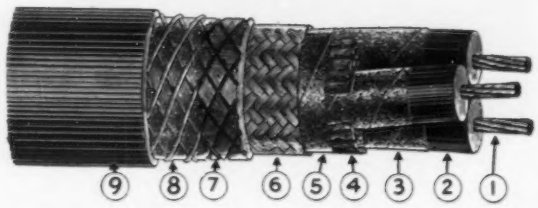
Type SH-A



1. Conductor
2. Rubber Insulation
3. Tape
4. Copper Braid
5. Jute Filling
6. Tape
7. Inner Jacket
8. Seine Twine Reinforcement
9. Outer Jacket

SH—A portable conductors have shields on individual conductors, but contain no ground wires. Simplex-Tirex.

Type SH-B



1. Conductor
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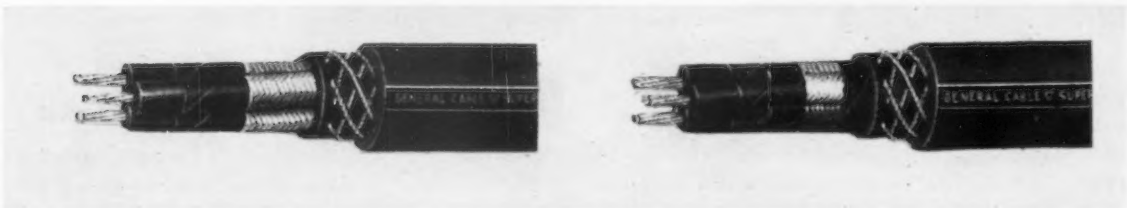
3. Tape
4. Jute Filling
5. Tape
6. Copper Braid
7. Inner Jacket
8. Seine Twine Reinforcement
9. Outer Jacket

SH—B portable conductors have shield over three- or four-wire assembly, but contain no ground wires. Simplex-Tirex.



SH—A cable for portable mine use shows shielding on three conductors and reinforced jacketing. General Cable, Supertuf.

SH—B portable cable shows conducting shield encircling three insulated conductors in cable core. General Cable, Supertuf.

Type SH-D. Three- or four-conductors power cable with shield on individual conductors, and with grounding conductors.

Each of these types is illustrated in this section, as well as the types and distribution of components used in the manufacture of standard cables of this type.

In general, as the voltage is increased, and the necessity for protection to personnel and equipment becomes more acute, the more complex the cable required to do the job.

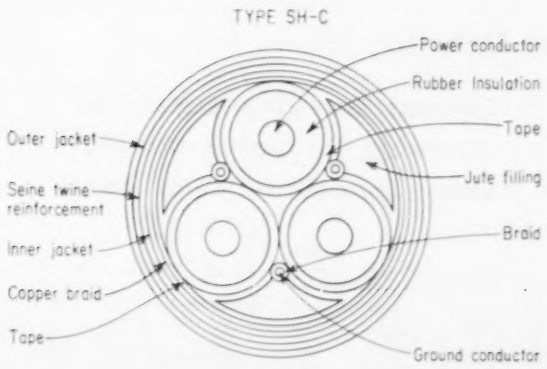
Other types of portable cables such as the single-conductor and two-conductor-mining-machine cables are also illustrated.

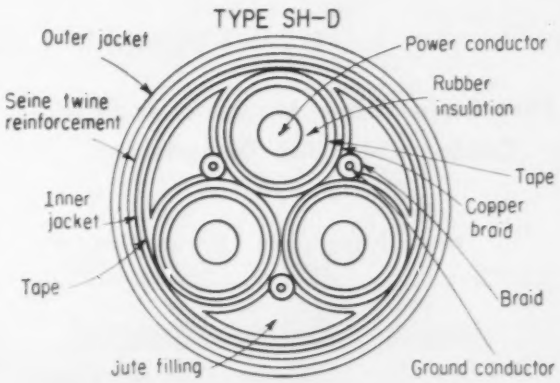
Other Types of Conductors

When you collect manufacturers' literature on conductors for your mine library, you will note two types of designations for the products in this field: (1) Code types, such as R, for rubber-covered conductors, and RHL, for rubber-covered, heat-resistant, lead over-all, and (2) trade name designations such as "SECURITYFLEX," for flexible cord or cable with mold-cured jacket, or "SUPERTUF," for heavy-duty portable cables as illustrated.

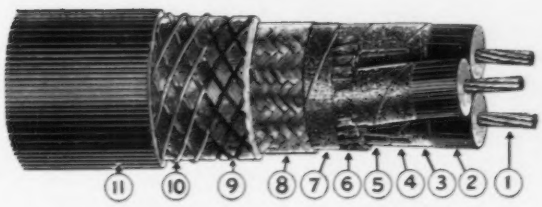
Here are some of the important code designations which are standard for all makes of conductors:

R— Rubber-covered
RH— Rubber-covered, heat resistant
RW— Rubber-covered for wet locations
RHW—Rubber-covered for heat- and wet-resistant installation
T— Thermoplastic-covered
TW— Thermoplastic-covered for wet locations
RL— Rubber-covered, lead over-all
RHL— Rubber-covered, heat-resistant, lead over-all
RWL—Rubber-covered, wet-resistant, lead over-all
RD— Twin-wire, rubber insulated, fibrous-covered
RHD, RWD, RDL, RHDL, RWDL, same as above for single-wire, R conductors





Type SH-C



1. Power Conductor
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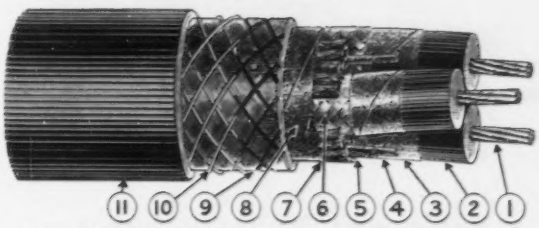
3. Tape
4. Ground Conductor
5. Braid
6. Jute Filling
7. Tape
8. Copper Braid
9. Inner Jacket
10. Seine Twine Reinforcement
11. Outer Jacket

SH—C portable conductors have shield over three- or four-wire assembly, with grounding conductors. Simplex-Tirex.

Type SH-D



1. Power Conductor
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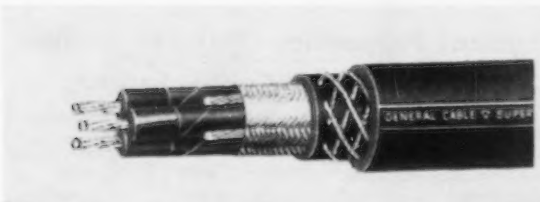
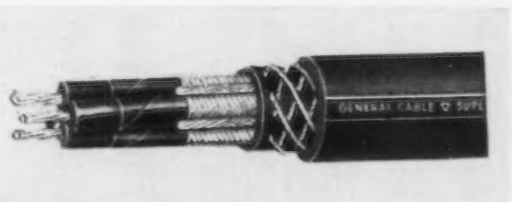
3. Tape
4. Ground Conductor
5. Braid
6. Copper Braid
7. Jute Filling
8. Tape
9. Inner Jacket
10. Seine Twine Reinforcement
11. Outer Jacket

SH—D portable conductors have shields on individual conductors, and on grounding conductors. Simplex-Tirex.



SH—C portable cable contains three ground wires and insulated conductors within conducting shield. General Cable.



SH—D portable cable consists of three individually shielded conductors plus three ground wires. General Cable, Supertuf.

CABLES MUST BE DESIGNED to fit application. Type used here must be flexible and have abrasion-resistant covering.

Useful Portable Cable Data for Mines

Flat Twin Mine Machine Trailing Cables Over-All Dimensions, 600-V WP, In.

Cond. size	Without grounding cond. Major	Without grounding cond. Minor	With grounding cond. Major	With grounding cond. Minor
8	0.84	0.51	—	—
6	0.93	0.56	1.02	0.56
4	1.05	0.61	1.15	0.61
3	1.14	0.68	1.26	0.68
2	1.24	0.73	1.35	0.73
1	1.40	0.81	1.55	0.81
1/0	1.51	0.93	1.67	0.93
2/0	1.63	0.99	1.85	0.99
3/0	1.77	1.03	2.00	1.03
4/0	1.89	1.10	2.10	1.10

All tolerances—Major dimension ± .04 in.
Minor dimension ± .03 in.

Single and Multi-Conductor Round Trailing Cables Outside Diameters, 600-V WP, In.

Cond. Size AWG	Single cond.	Two-conductor Conc.	Two-conductor Twisted	Three cond.	Four cond.	Five cond.	Six cond.
8	0.44	0.65	0.81	0.91	0.99	1.07	1.18
6	0.51	0.77	0.93	1.01	1.10	1.21	1.31
5	0.52	0.80	1.01	1.10	1.19	1.29	1.39
4	0.57	0.84	1.08	1.17	1.27	1.40	1.52
3	0.63	0.89	1.17	1.24	1.34	1.48	1.61
2	0.66	0.94	1.27	1.34	1.48	1.61	1.75
1	0.74	1.05	1.44	1.51	1.68	1.88	2.05
1/0	0.77	1.10	1.52	1.65	1.79		
2/0	0.82	1.18	1.65	1.75	1.93		
3/0	0.87	1.24	1.77	1.89	2.07		
4/0	0.93	1.33	1.92	2.04	2.26		

All tolerances—

Single cond. and 2 to 4-cond.	#8 to #1	±	0.03 in.
	#1/0 to #2/0	±	0.04 in.
	#3/0 to #4/0	±	0.05 in.
5 and 6-cond.	#8 to #4	±	0.03 in.
	#3 to #1	±	0.04 in.

Current Carrying Capacities Portable Rubber-Insulated, Rubber-Sheathed Power Cable

A.W.G. or M.C.M.	1-Cond.	2-Cond. conc.	2-Cond. twin and round	3-Cond.	4-Cond.
	Amperes per conductor				
8	45	—	40	35	30
6	60	50	50	50	40
4	85	65	70	65	55
3	95	75	80	75	65
2	110	90	95	90	75
1	130	100	110	100	85
1/0	150	120	130	120	100
2/0	175	135	150	135	115
3/0	205	160	175	155	130
4/0	235	180	200	180	150
250	275		220	200	160
300	305		240	220	175
350	345		260	235	190
400	375		280	250	200
450	400		300	270	215
500	425		320	290	230
550	450				
600	475				
650	495				
700	520				
750	540				
800	560				
900	600				
1000	645				

Physical Properties—Natural Rubber and Neoprene Cable Jackets

	Natural rubber H.S. comp.	Neoprene H.S. comp.
Initial ten. str.—lb/sq in.	4000	3000
Initial elong.—%	500	450
After 96 hr in oxygen bomb		
Tens. str.—% of initial	65	80
Elongation—% of initial	75	90
Tear resistance—lb/in.	60	100
du Pont abrasion		
Vol. loss—cc/hp hr	140	75
Flame resistance	None	Excellent
Light resistance	Fair	Excellent

RM— Rubber-covered, multiple conductors

RHM, RWM, RML, RHML, RWML, same as above for R conductors

V— Varnished, cambric-covered wire

A— Asbestos-covered wire

WP— Weatherproof wire

Many others are specified, in addition to these common types.

What to Use Where

Engineers and cable and conductor manufacturers have published a number of application charts for various types of cables and conductors used in the mining industry. A digest of these recommended applications follows:

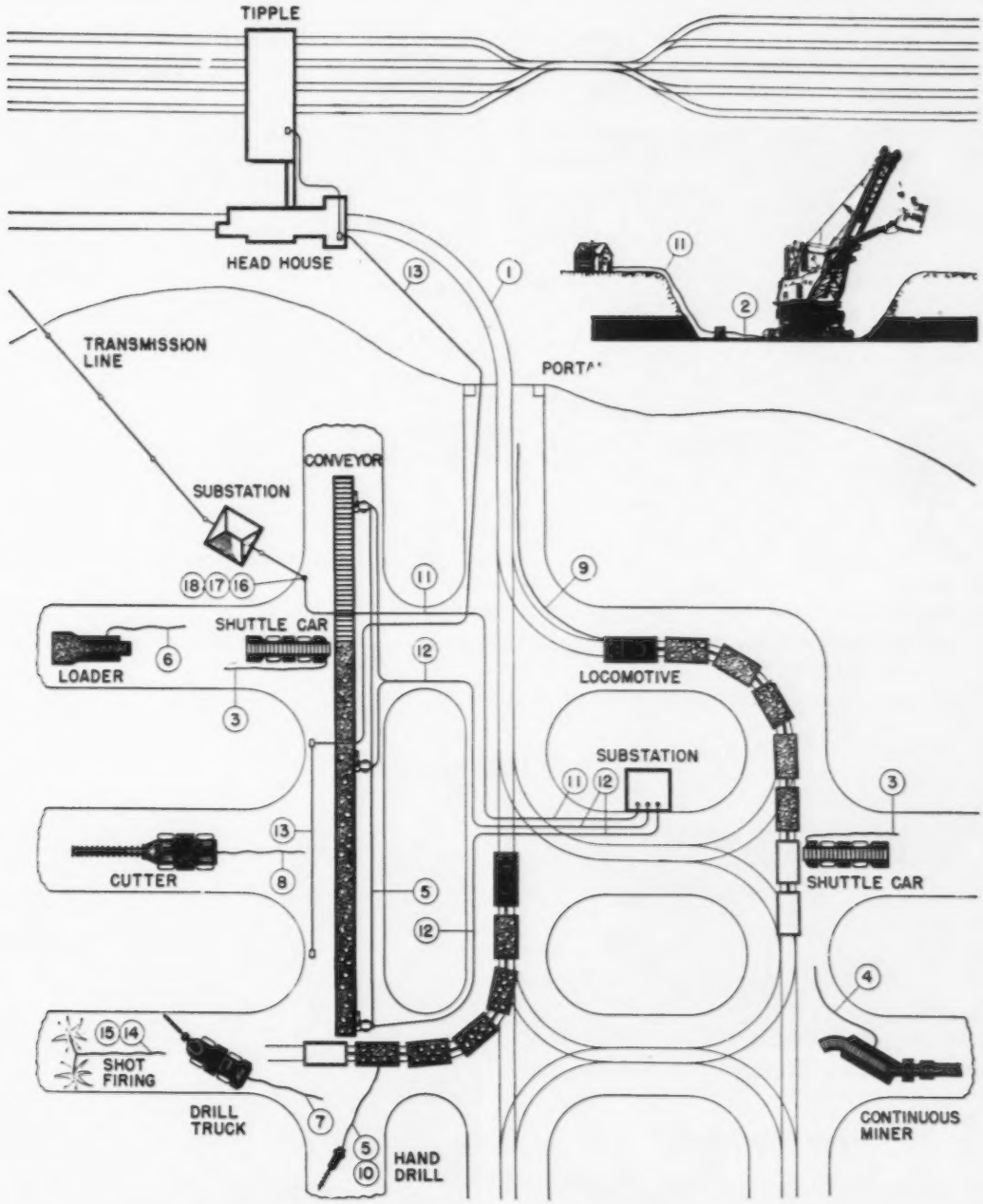
For shovels, dredges, and draglines: Types W. G., SH-A, SH-B, SH-C, SH-D. Types W and G are suggested for units up to 2kv, and occasionally up to 5 kv. The types SH, shielded, are recommended for 2.1 to 7 kv. Of the four shielded (SH) types, the SH-D type is most popular.

For shuttle cars: A flat, twin-type cable in the W and G families is recommended for rigorous duty. New cables consisting of two conductors of improved stranding for greater flexibility, cold-rubber insulation, and special super-strength neoprene jackets are available for this purpose.

For electric-powered loaders: Twin-conductored G and W types are recommended.

For track-mounted, rubber-tire mounted, or caterpillar-mounted mining machines such as kerf-cutters, etc.: Portable round or twin types W and G are suggested.

For mine conveyor systems: Two-conductor round or twin-type W and G conductors are recommended.

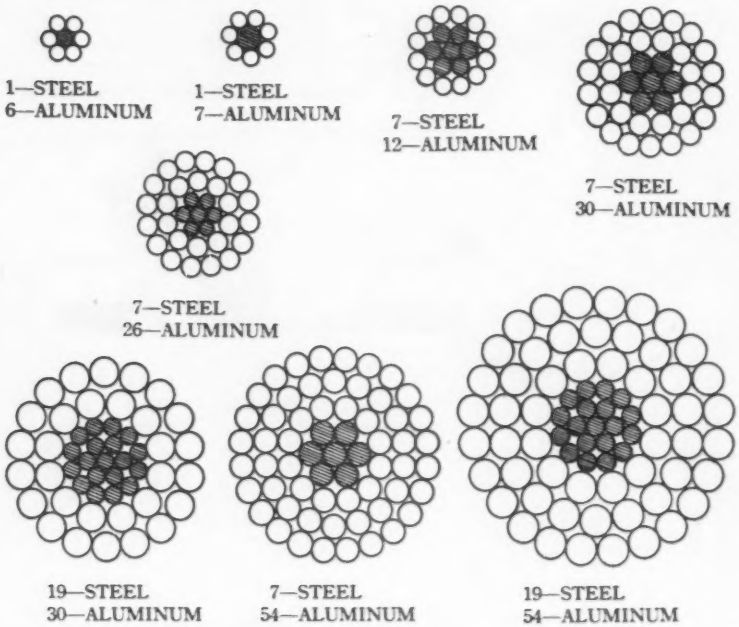


Types of Conductors Used on Surface and Underground[2]

CABLE APPLICATIONS shown in the composite coal mine and plant above illustrate the major types of cables used in open-pit and underground metal and nonmetallic mines as well. Key to the numerals on the schematic layout above is as follows:

(1) Trolley wire. **(2)** Shovel cable. **(3)** Shuttle-car cable. **(4)** Continuous mining-machine cable. **(5)** Remote-control and heavy-duty drill cord. **(6)** Loader cable. **(7)** Drill-truck of jumbo cable. **(8)** Mining-machine (cutting) cable. **(9)** Gathering-locomotive cable. **(10)** Hand-drill cord. **(11)** Mine power cable. **(12)** Low-voltage power and feeder cable. **(13)** Telephone cable. **(14)** Shot-firing cord. **(15)** Blasting-cap wire. **(16)** Borehole and mine-shaft cable. **(17)** Suspension unit for borehole cable. **(18)** Armored cable suspension unit.

This list does not include the many types of conductors and cables used in mine-plant construction, for high-tension overhead power transmission, etc. Examples of the various conventional and special cable types for the applications listed above are shown on the accompanying pages, together with suggestions to guide the mine operator in the selection of the types which will do the job best for a particular application.



STRANDED ALUMINUM CABLES with steel cores are designed for overhead power transmission and distribution. Types shown here are General Cable, A.C.S.R.[9]

Aluminum Wires and Cables

Cable and wire manufacturers have been adding new aluminum conductors to their lines during the past decade. These include rolled aluminum rods; hard-drawn aluminum wire; concentric lay-stranded aluminum conductors, steel-reinforced; and standard weight, zinc-coated (galvanized) steel core wire for aluminum conductors, steel-reinforced. Aluminum conductors, steel-reinforced, designated as A.C.S.R., are extensively furnished for overhead line used for both distribution and transmission. Other aluminum types include rubber-covered and armored conductors, and special alloy conductors. Since the lightness of aluminum offers very definite advantages for certain installations such as overhead high-tension transmission, many manufacturers make both aluminum and copper conductors, with recommendation to use each type where best suited.[9] See installation of high-line below.

COILS OF STRANDED ALUMINUM overhead, high-voltage conductor await installation at Canadian mine power project.

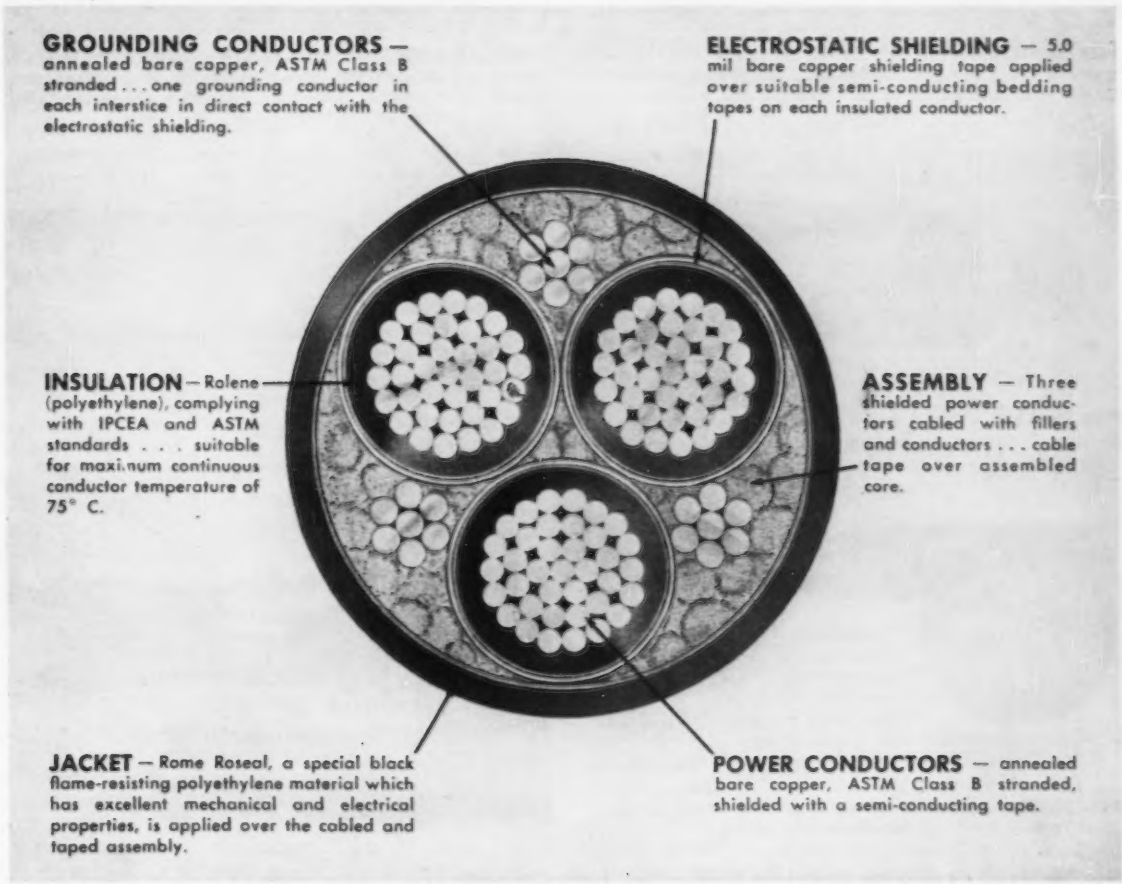
New Glossary

Terminology in the rubber industry is undergoing change. The old wartime designations (GRS, GRA, etc.) are outmoded. The American Society for Testing Materials has published a suggested system of nomenclature. (ASTM-D1418-56T). You may be seeing some of these new initials in print. (Source: DuPont Co.)

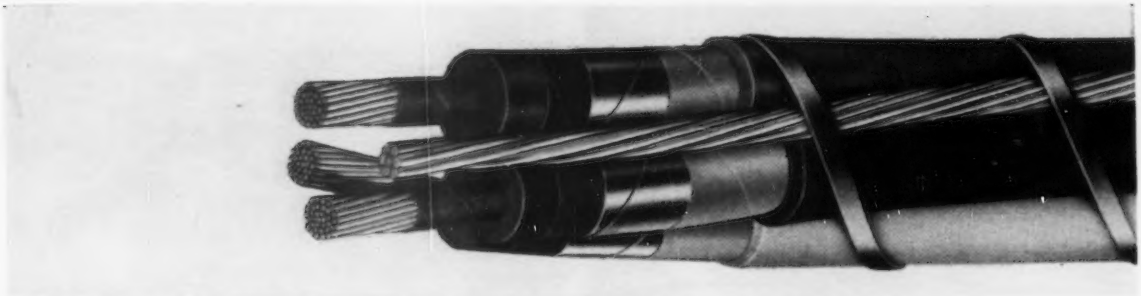
ASTM Initials	Composition	Common Name
IR	Isoprene rubber, synthetic	Natural Synthetic
CR	Chloroprene rubbers	Neoprene
NR	Isoprene rubber, natural	Natural rubber
ABR	Acrylate-butadiene rubbers	Polyacrylic rubber
IIR	Isobutylene-isoprene rubbers	Butyl
NBR	Nitrile-butadiene rubbers	Buna N or Nitrile rubber
SBR	Styrene-butadiene rubbers	GR-S

ALUMINUM CONDUCTORS proved best in this new 138,000v high-altitude transmission line completed recently to carry power from Cerro de Pasco's Paucartambo power plant to the metallurgical center at La Oroya, Peru. One span in this area stretches 3,720 ft. Three transmission lines are steel-reinforced, 477,000-circular-mil, aluminum type.

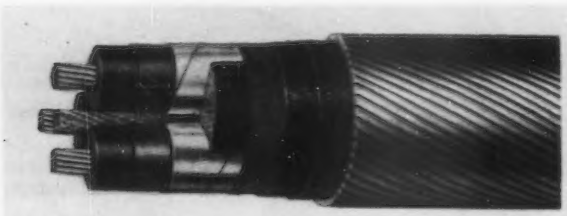
MINE PLANTS, MILLS, AND SMELTERS in modern projects are heavy power users. The tunnel shown above connects plants at Chuquicamata. Note the orderly arrangement of power cable conduits and water lines in the tunnel between buildings. A tunnel carrying water lines, steam lines and power cables is used at the Barvue surface plant in Quebec (left.) Fireproof transite conduit has gained wide acceptance.


GROUNDING CONDUCTORS — annealed bare copper, ASTM Class B stranded . . . one grounding conductor in each interstice in direct contact with the electrostatic shielding.
ELECTROSTATIC SHIELDING — 5.0 mil bare copper shielding tape applied over suitable semi-conducting bedding tapes on each insulated conductor.
INSULATION — Rolene (polyethylene), complying with IPCEA and ASTM standards . . . suitable for maximum continuous conductor temperature of 75° C.
ASSEMBLY — Three shielded power conductors cabled with fillers and conductors . . . cable tape over assembled core.
JACKET — Rome Roseal, a special black flame-resisting polyethylene material which has excellent mechanical and electrical properties, is applied over the cabled and taped assembly.
POWER CONDUCTORS — annealed bare copper, ASTM Class B stranded, shielded with a semi-conducting tape.

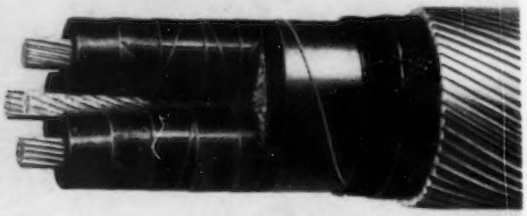
CONSTRUCTION OF A MINE POWER CABLE suitable for installation in boreholes, shafts, horizontal mine runs, aerial suspension on insulators, and to connect the main circuit breakers with the ac underground load center. Note that one grounding connector is in direct contact with the electro static shielding around each power conductor. This type of cable is made with either neoprene jacket or thermoplastic jacket. Rome Cable Corp., Type MP.[15]



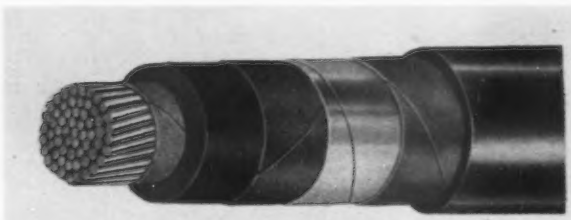
FOR MINE TUNNEL POWER FEEDERS, this assembly offers the advantage of a carrying messenger cable which is bound to three single-conductor, sheathed insulated cable. Spiral copper strip ties the assembly together. Kaiser Aluminum[8].



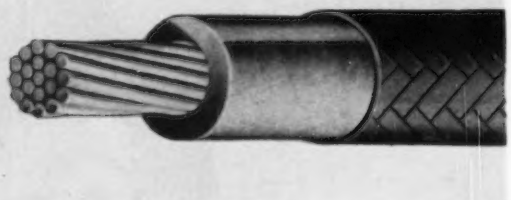
FOR BOREHOLES AND MINE SHAFTS. This steel-wire armored cable can be installed in places where considerable tension is exerted on the cable. General Cable Borehole Type[9].



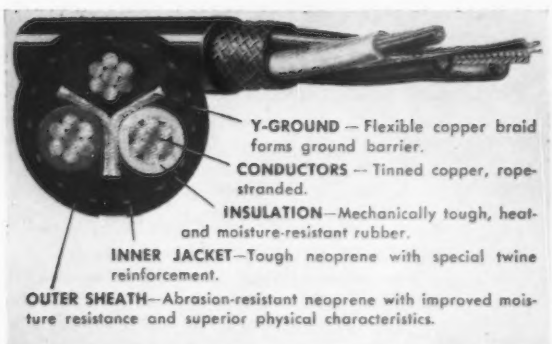
FOR DREDGES AND SHOVELS. Wire-armored cable (shown above) is designed for semi-portable use. Galvanized steel-armor wire provides longitudinal strength. General Cable.[9]



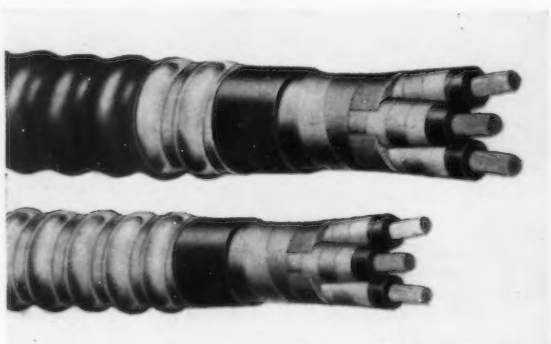
FOR INSTALLATIONS where power cable is exposed to corrosive acids, fumes, oil, moisture and chemicals, thermo-plastic insulated cables are recommended. Rome Cable, Roseal.[10]



FOR HOT PLACES. Single conductor insulated with silicone rubber, and covered with black asbestos braid resists temperatures up to 125 deg C. General Electric SI-58210-B.[13]

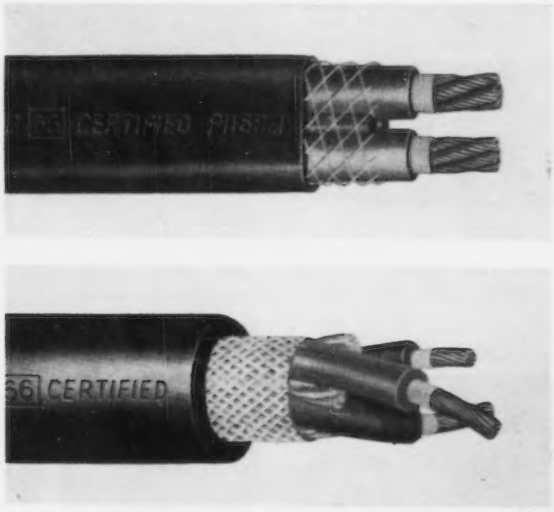

Y-GROUND — Flexible copper braid forms ground barrier.
CONDUCTORS — Tinned copper, rope-stranded.
INSULATION—Mechanically tough, heat- and moisture-resistant rubber.
INNER JACKET—Tough neoprene with special twine reinforcement.
OUTER SHEATH—Abrasion-resistant neoprene with improved moisture resistance and superior physical characteristics.

FOR SHUTTLE CARS AND LOADERS. Portable cable has Y-ground construction consisting of flexible copper braid. It offers protection against phase-to-phase faults provided by a cable with a shielded construction, without the complication inherent in a fully shielded cable. General Electric Y-type.

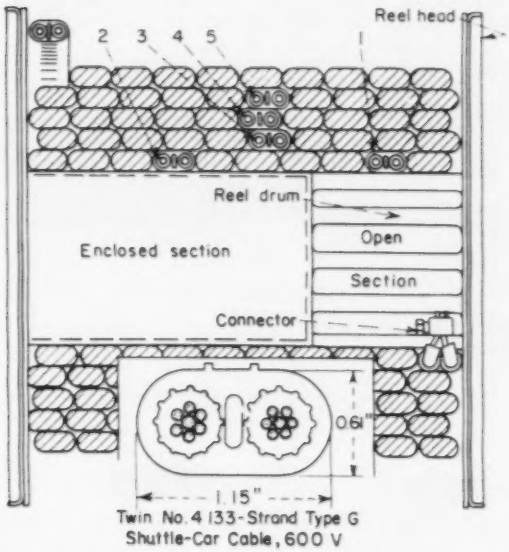


INTERLOCKED ARMOR CABLES are designed for primary and secondary feeders in mine power distribution systems, and for generator leads, station auxiliaries and station control cables in mine electric power stations. Two shielded types shown above have thermoplastic jackets. General Electric Co.[12]

PORTABLE POWER CABLE has butyl rubber conductor insulation permitting operation with copper temperatures up to 90 deg C. Roebling SH-D Portable Power Cable.



FLAT-TWIN portable cable for mining equipment (top) and retractable cable also for cable-reel installations in mines. Western Insulated Wire Co. Type 66.



CURRENT-CARRYING capacities shown in table (at right) were determined by making tests and recording data with cable-reel with cross section shown above. Thermocouples were placed at positions indicated. Inset shows twin No. 4 shuttle-car cable used in experiments.[11]

Current-Carrying Capacity For Cables on Reels

Cable manufacturers report that when power cables are used on reels for portable mine equipment, such cables are unable to carry the same loads that un-reeled portable cables do because of temperature build-ups on the reel and other factors. In other words, the current-carrying capacity must be derated. Experiments were conducted by John McNiff and A. H. Shepherd of Simplex Wire & Cable Co. to determine derating factors, and reported in *Coal Age*, January 1958. Results as excerpted from the article are given here, together with a cross section of the test reel used to determine the derating factors reported. Tests have shown that the maximum recommended conductor temperature rating of 60 deg C (140 deg F) is best for trailing mine cable if maximum service life is to be realized.[11]

Current-Carrying Capacities, Portable Rubber-Insulated Rubber-Sheathed Power Cable

AWG	1-Cond	2-Cond concentric, amp per conductor	2-Cond twin or round
8	45	...	40
6	60	50	50
4	85	65	70
3	95	75	80
2	110	90	95
1	130	100	110
1/0	150	120	130
2/0	175	135	150
3/0	205	160	175
4/0	235	180	200

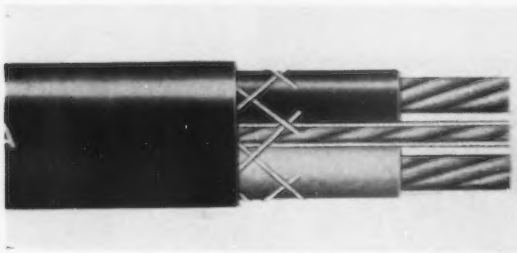
This table assumes a maximum conductor temperature of 140F (60C) and a maximum ambient temperature of 104F (40C). Correction factors for other ambient temperatures are as follows:

Ambient temperature		Correction factor
10C	50F	1.58
20	68	1.41
30	86	1.22
40	104	1.00
50	122	0.71

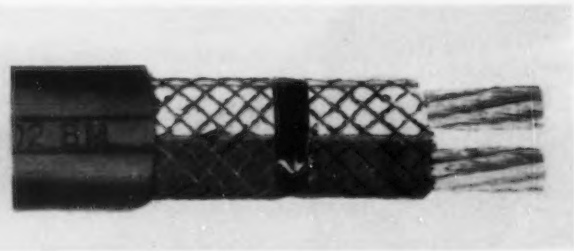
Derating Factors

When the cables are used with one or more layers wound on a gathering reel, the current-carrying capacities shall be corrected as follows:

Number layers	% of specified values
1	0.85
2	0.65
3	0.45
4	0.35

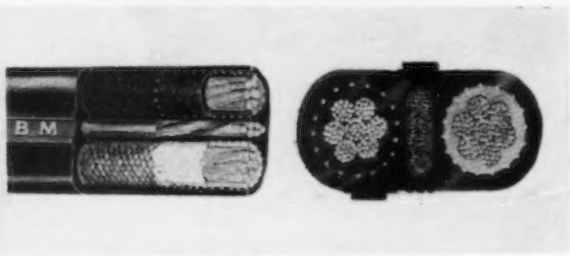


PARALLEL MINING MACHINE cable design for continuous mining units with grounding conductor. Anaconda.[8]

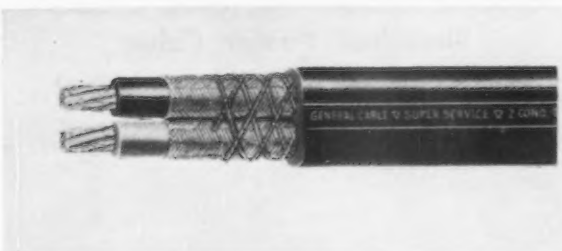


PARALLEL MINING MACHINE cable for continuous mining units without grounding conductor. Anaconda.[8]

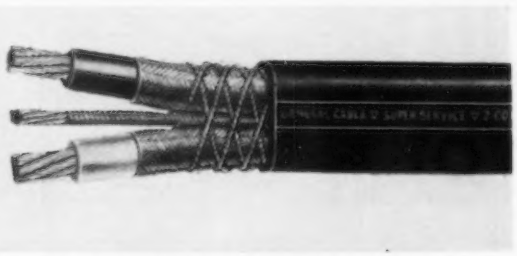
SHUTTLE CAR CABLE has rib-shaped conductors to increase jacket-to-conductor adhesion. Simplex-Tirex, 600 VWP.[5]



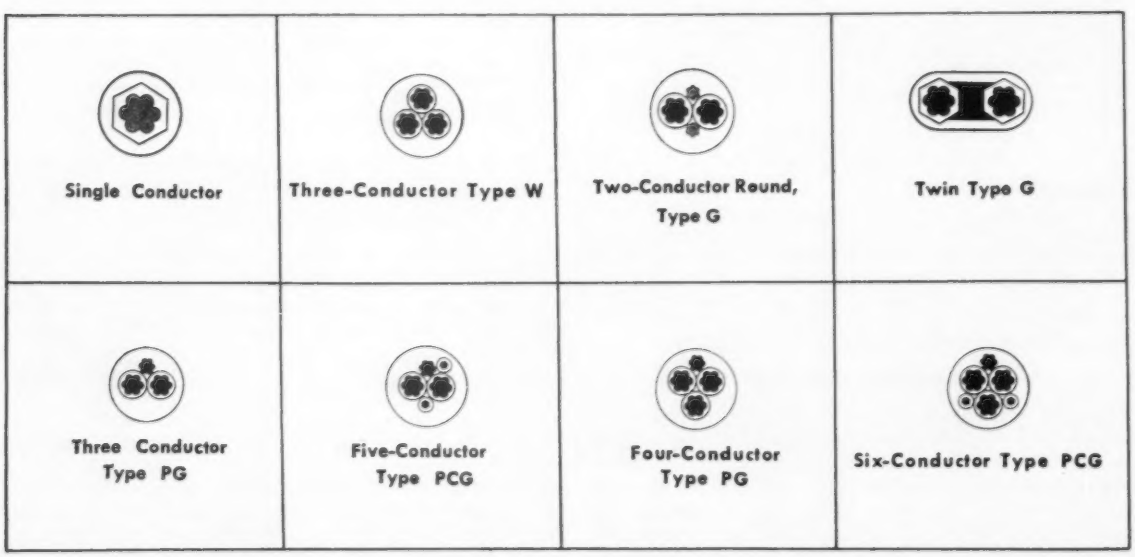
SHUTTLE CAR CABLE constructed to resist damage by bending. Resilient web offers protection. Rome, P-105 BM.[15]



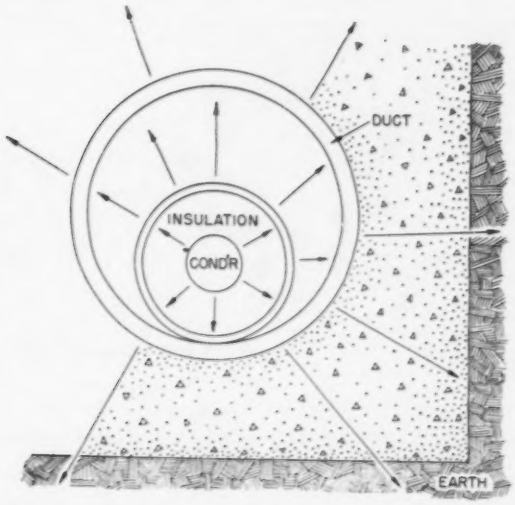
MOBILE MINE MACHINE CABLE, type W, flat-type for 600 to 1,000v service. General Cable Co. Super-service.[14]



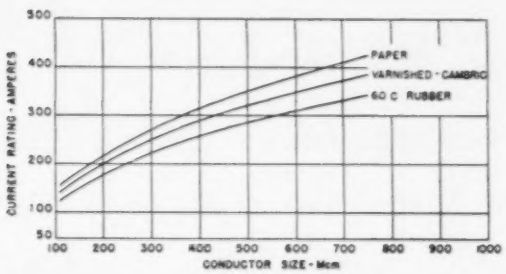
MOBILE MINE MACHINE CABLE, type G, with ground wire for 600 to 1,000v service. General Cable Co. Super-service.[14]



STANDARD CONSTRUCTION cables for mine service are shown on the top row. Same manufacturer will also make special-type cables as shown in the second row for new types of mine equipment with special problems. Okonite Cable Co.



HEAT produced by current flow in conductors, sheathing and insulation (for high voltages) has a limiting effect on current ratings for various cables and installations.[3]

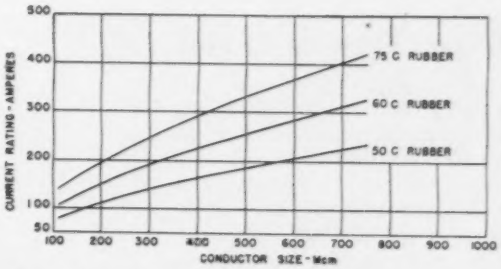


HOW TYPE OF INSULATION affects the safe amount of current (current rating) which conductors of various sizes can carry. Curves above apply to three 3-conductor, shielded type cables in duct operating at 100% load factor, 20 deg c, 3 cables per duct bank.[2]

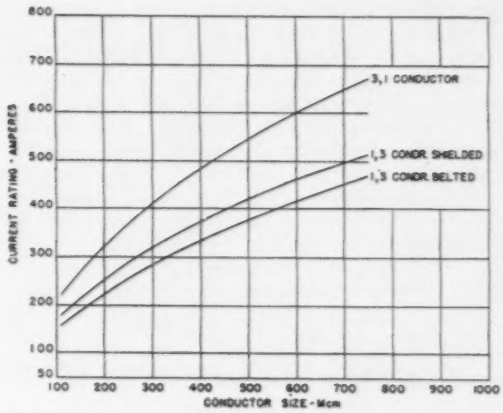
Factors Which Affect Safe Loads For Electric Cables and Conductors

The charts above show how type of cable, insulation and installation will affect the safe current load (current rating) which can be carried by cables and conductors. Tables compiled under the National Electrical Code are available for standard conductors of all types. However, great care must be used in applying data from these tables because of such additional factors as voltage regulation, circuit length, energy losses and others which affect the practical application of conductors.

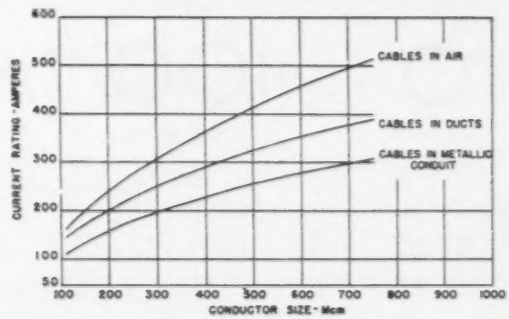
Heat generated in cables is particularly important as a limiting factor. Heat is generated in conductors because of resistance, in insulation (dielectric losses) in high-voltage installations, and in the sheathing where induced currents generate heat when encountering the resistance in the sheathing. In single-conductor cable in which induced (or sheath current) are permitted to flow, sheath losses can be so high as to materially reduce useful current rating. In such cases it is customary to use special bonding to reduce or eliminate sheath losses.[2]



HOW GRADE OF RUBBER affects current ratings for conductors of various sizes. Data above is for three 1-conductor cables in conduit at 100% load factor, 40 deg C, 3 cables per conduit.[2]



HOW CABLE CONSTRUCTION affects current ratings for conductors of various sizes. Data above for 1-conductor and 3-conductor, 15-kv cables in ducts at 100% load factor and 20 deg C ambient temperature. For three 1-conductor cables per duct bank, or one 3-conductor cable per duct bank.[2]



HOW TYPE OF INSTALLATION affects current ratings for conductors of various sizes. Data above is for three cables, not confined, at 100% load factor and 40 deg C in air; for three cables per duct bank at 100% load factor and 20 deg C in ducts; and three conduits per group at 100% load factor and 40 deg C. All conductors are 3-conductor, 15-kv, shielded type, varnished cambric-insulated cables.[2]

National Electrical Code recommends maximum voltage drops of 3% for power circuits and 1% for combined lighting and power. Voltage regulation can be improved by: 1) Using a larger conductor, 2) reducing conductor spacing, 3) dividing or "paralleling" circuits, and 4) improving power factors with synchronous motors or capacitor installations.

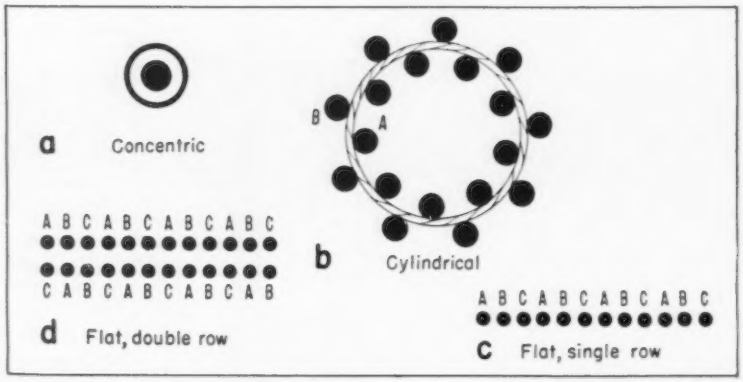
Electric Furnace Cables

Cables for electric furnace leads are principally: single-conductor concentric-stranded, single-conductor annular-stranded, single-conductor rope-lay-stranded, and two-conductor concentric-stranded. Types of insulation, and maximum allowable temperature rise of conductor for each type of insulation are as follows: Asbestos, 200 deg C; asbestos-varnished-cambric, 100 deg C; and varnished-cambric, 85 deg C. Several cable arrangements are shown here. These are designed for good ventilation, and minimum inductance, and should result in a minimum of reactive current; hence, greatest economy.

For single-phase circuits of low current, say 1,000 amp, the most economical arrangement is Fig. a. For single-phase circuits of high currents, say 30,000 amp, a cylindrical configuration, as in Fig. b, is a good arrangement. For three-phase circuits above 6,000 amp, arrangements of cables in flat configurations as in Fig. c and Fig. d are suggested. The same results electrically are achieved by keeping the same conductor arrangement, but in cylindrical configuration instead of flat.

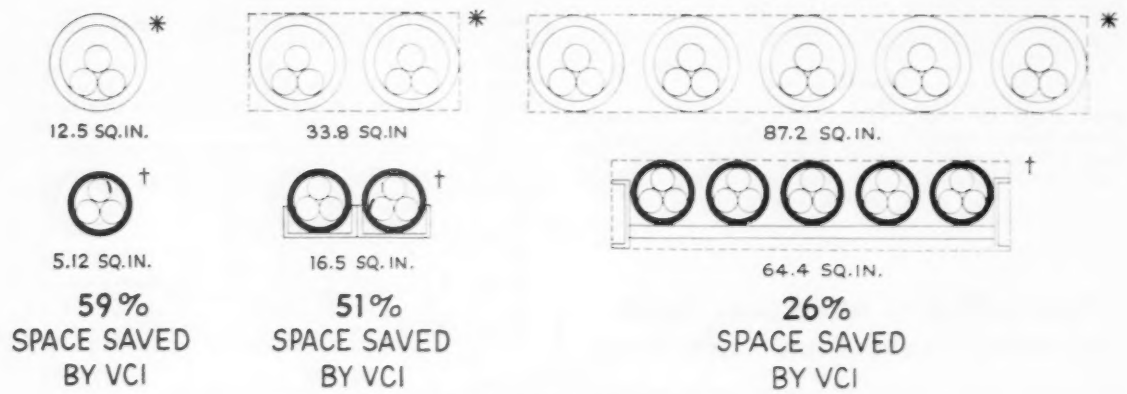
For three-phase circuits, 2,000 to 6,000 amp, it is preferable to run the bus as close as practicable to the electrodes and arrange cables as closely to those of Fig. c and Fig. d as is convenient.[2]

Other valuable hints on bus conductors are published in Anaconda's publication No. C-25, "Bus Conductors."



TYPICAL ARRANGEMENTS for cable conductors for bus and furnace leads. Arrangements a and b are for single-phase; c and d for three-phase.[2]

COMPARATIVE SPACE SAVINGS



* 3-500 MCM RUBBER CABLES IN 3-INCH CONDUIT

† 3/c 500 MCM VCI CABLES, SI-2345

DIAGRAMS SHOW COMPARISON of space required for a General Electric 3-conductor, 500 mcm, V-c interlocked armor (VCI) cable and for three single-conductor 500-mcm rubber cables in conduit. The space saving occurs whether there are one or several cables. However, the percentage of space saving is less for the larger number of cables. General Electric[12].

References for This Section

E&MJ acknowledges with thanks the assistance of numerous cable manufacturers and engineers who contributed bulletins, manuals and articles related to the subject of mine cables and conductors. Footnotes throughout the text and captions refer to the following sources of material:

[1]H. R. Stoddard, "Modern Design of Cables for Mining Operations," AIME Regional Meeting, Tampa, Fla., October 1957. Simplex Wire & Cable Co.

[2]Anaconda Wire & Cable Co., "Application of Wire and Cable," Publication C-68, third edition.

[3]Kaiser Aluminum and Chemical Co., "U.S. Electrical Wires and Cables" and "U.S. Electrical Wires and Cables for the Electric Utility Industry". These booklets were formerly published by U.S. Rubber Co.

[4]Okonite Co. Bulletin 1096, catalog section.

[5]Simplex Wire & Cable Co., "Simplex-Tirex Portable Cables for High Voltages."

[6]Kaiser Aluminum and Chemical Co., "Electrical Wires and Cables for Electric Utility Industries."

[7]Circle Wire & Cable Corp., "Circlesheath Type RR Cable."

[8]Anaconda Wire & Cable Co., "Securityflex Portable Cables and Cords."

[9]General Cable Corp., "Electric Wire and Cables," Catalog 490.

[10]Rome Cable Corp., "High Voltage Mine Power Feeder Cables."

[11]McNiff and Shepherd, Simplex Wire & Cable Co., "Current Carrying Capacities, Portable Power Cable Reels." Published in *Coal Age*, January 1958.

[12]General Electric Co., "Interlocked Armor Cable."

[13]General Electric Co., "Silicone Rubber Wire and Cable."

[14]General Cable Corp., "Super-Service Heavy Duty Portable Cords and Cables."

[15]Rome Cable Corp., "Guide to Representative Wire, Cable and Conduit Manufactured by Rome Cable Corp."

[16]U.S. Steel Corp., American Steel & Wire Div.

ON TOP OR UNDERGROUND, the problem of protecting men from injury by stray currents (grounds) that leak through conductors into the frames of equipment is equally important. This article tells you how to whip the problem.

What Mine Management Should Know About Ground Fault Protection

G. J. REYNOLDS

THE PURPOSE OF THIS PAPER is to review the necessities for the 480-v ground fault protective system for portable mining machinery, the several types now on the market and possible misapplications to be avoided at installations of adequately designed equipment in this respect.

There are three basic types of 480-v current-limiting resistance-grounded fault protective systems based on the common principle employed for the 2,400- and 4,160-v systems. It is hoped that this discussion will stir enough interest among operators and manufacturers so that the three 480-v systems mentioned can be perhaps resolved into one common basic system employing one type of equipment, similar to the way the 4,160-v protective system has finally resolved itself.

Equipment that we are concerned with grounding always consists of that, the frame of which, personnel is exposed to and which could become energized through insulation failure and thus create severe shock hazard. In this case we are dealing with main substations and fence, switchgear at the end of overhead power line between power line and power cable circuits to mobile machinery, and the mobile machinery itself such as shovels, draglines, drills, pumps, and in underground mines cutting machines, loading machines and buggies.

Important Definitions

The term "Ground" means earth potential which is the same in all parts of the earth, or in any object that touches the earth through zero resistance.

"Ground Bus" is a protective ground network used to establish a uniform potential in and about the structure. It is tied solidly to the grounding electrodes.

"Equipment Ground" is a connection to earth by grounding conductor to ground rod or ground bus from the non-energized frame of the equipment, to achieve a uniform potential at all times of normal and abnormal system conditions.

Objectives of equipment grounding are twofold:

This article represents a condensed version of a paper, "480-Volt Ground Fault Protective Systems," which Mr. Reynolds, electrical engineer for U. S. Gypsum Co., presented at the annual meeting of the Open Pit Mining Association, University of Illinois, June 1957.

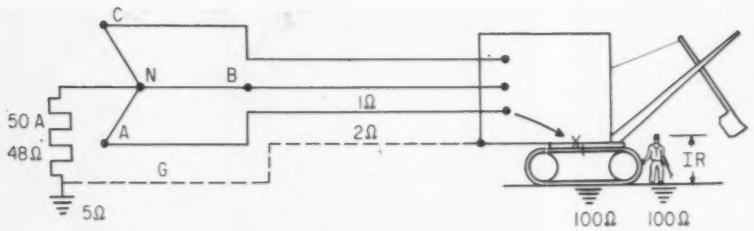


FIG. 1. The 4,160-v ground-fault protective systems widely used today.

1. Limit the potential between the non-current carrying frames of the equipment and parts of the plant between them and the earth to a safe value under the most adverse conditions.

2. Provide a low resistance return path to the transformer neutral to eliminate the dangerous potential difference personnel could be exposed to, consisting of a high IR drop due to the high resistance path to ground, and to facilitate the tripping of the faulted circuit.

At the time of a second simultaneous ground fault through a high resistance connection to ground, personnel are exposed to dangerously excessive values of voltage.

"Grounded System"—A grounded system is a system of conductors in which at least one conductor or point (usually the middle wire or neutral point of transformer or generator windings) is intentionally grounded, either solidly or through a current-limiting device.

"Ungrounded System" — Ungrounded means without an intentional connection to ground except through potential indicating or measuring devices.

"Resistance Grounded System"—Resistance grounded means grounded through impedance, the principal element of which is resistance.

"Ground on System" is an electrical connection to ground, unintentional or otherwise, from one of the electrical current-carrying conductors.

"Ground Fault" means failure of electrical insulation between phase and ground wires allowing an electrical connection.

"Ground Fault Current" is the current flow between the phase and ground circuit at the time of ground fault.

A simple fundamental to remember in relation to flow of ground fault current is that theoretically an ampere that flows out of one transformer terminal must find its way back through some other terminal. In ground fault, if there is no transformer neutral connection to ground as on an ungrounded system there is no current flow and therefore there is no IR drop or potential difference across a person touching a machine frame. Practically, however, there is capacitive coupling to earth and on an ungrounded system a phase to ground fault will cause an indeterminate current flow due to capacitance of the cables, transformers, motors, etc. of the system. Theoretically, a man could stand on the earth and touch any one phase wire of an ungrounded system but practically he is exposing himself to a hazard of an indeterminate force.

What a Ground Fault Protective System Should Do

1. Protect personnel from exposure to dangerous voltages to ground while carrying out their normal operating duties near mobile mining machinery, by limiting the voltages to ground to a safe value for man.

2. Protect insulated electrical equipment from severe damage at time of failure of insulation by limiting the current flow through the damaged spot and removing the equipment as quickly as possible from the power source at time of fault.

3. Isolate the faulted portion of the system instantly at time of fault without disturbing the balance of the system and thus limiting the outage time to the one faulted section only.

4. Limit the possibility of a second and simultaneous ground fault occurring in another section of the operation with its possibility of creating dangerously excessive voltages on the entire system with resultant possible loss of life and failure of large amounts of electrical equipment.

5. Reduce hazard of electrical power cable fires and at times loss of a shovel or other equipment due to fire because of high resistance fault causing just sufficient current to flow to cause excessive heat but not enough current to trip the overload breakers.

Essentials of a ground fault protective system are as shown on the diagram of the well-known 4,160-v ground fault protective system, Fig. 1, which is a standard in the open-pit mining industry today.

The 4,160-v system only is described, which has a wye neutral point but the same system is also applied to the 2,400-v Delta system by the simple addition of a zigzag grounding transformer sized only for the ground fault current and connected to the 2,400-v transformer terminals to provide the transformer wye neutral point. Hence, reference to the 4,160-v system only will be made.

This system consists of a wye connected transformer feeding a 4,160-v circuit through an automatic circuit breaker. Automatic in this usage means automatic trip at predetermined values but manual reclose. The 4,160-v circuit consists of three phase wires A, B, and C, a fourth ground wire, G, or three in the interstices of the cable the equivalent of one phase conductor. The ground wire is connected to the frame of the shovel, or other electrical equipment, at the cable junction box and affords a metallic, low resistance path back to the neutral point of the wye connected transformer.

This system basically employs equipment grounding by metallic path to a low resistance station ground bus of five amperes or less; a grounded system by providing a positive metallic low resistance path, with resultant low IR drop, back to the neutral of the transformer to provide a positive tripping current at ground fault; and a predetermined resistance at the transformer neutral to limit the ground fault current to a value large enough to adequately trip the ground relays and thus removing the faulted section from the system, and still small enough so that maximum allowable ground fault current under ideal ground conditions would never exceed 100 v to which personnel could be exposed.

The 4,160-v ground fault protective system is based on the principle of keeping the maximum voltage to ground that personnel could be exposed to anywhere on the system from the furthest machine back to the transformer, to less than 100 v.

Anything above 100 v is usually considered fatal.

Two ohms is arbitrarily selected as the maximum allowable resistance of the metallic ground return path from the furthermost machine back to the transformer neutral.

As 100 v is the maximum allowable voltage drop, or IR drop, this arbitrarily limits the maximum allowable current flow to 50 amp. Now with the phase to neutral voltage of 2,400 v, which is the 4,160 voltage divided by the square root of 3, impressed on the system, 48 ohms is required as the neutral resistor to limit the maximum current flow to 50 amp, with all other components of the system at zero resistance. This determines the maximum possible fault voltage of 100 v.

However, all other components of the system such as phase wire, switch gear, contacts of machine or man to ground have a certain resistance so the possible voltage is much less than 100 v and seldom exceeds 50 v.

Under the auspices of the Open Pit Mining Association and in cooperation with General Electric Co. and Westinghouse, and Mines Equipment Co. (now, Joy Company) developed the necessary equipment to ground a 480-v system, tested it under operation, packaged it and presented their recommendations at the 1947 Open Pit Mining Association meeting. Through development of compatible equipment the 480-v system is basically the same principle as the 4,160-v system and is the principle employed for the 480-v ground fault protective system as shown in Fig. 2.

However, we do not have a standard package of equipment components for the 480-v ground fault protective equipment and it appears that it would be most desirable to have a single standard of both operation and equipment for the 480-v system similar to that of the 4,160-v system, subject to manufacturing procedures, of course.

The current in the 480-v, wye-connected, current-limiting system is limited to a predetermined value by the addition of a resistor of specified value in the neutral or ground return circuit to the transformer. For present equipments available, the currents are limited in a range of from 5 to 35 amp as recommended by the various manufacturers. In this case 25 amp is arbitrarily selected as a suitable maximum ground current. The phase to neutral voltage of 277 v is divided by the 25 amp to determine the size of the current-limiting resistor as 11 ohms, assuming no other resistance in the ground fault circuit. Using the same 2-ohm value as in the 4,160-v system as the maximum allowable in the ground return path the maximum possible fault voltage is thus 25 amp times 2 ohms, or 50 v.

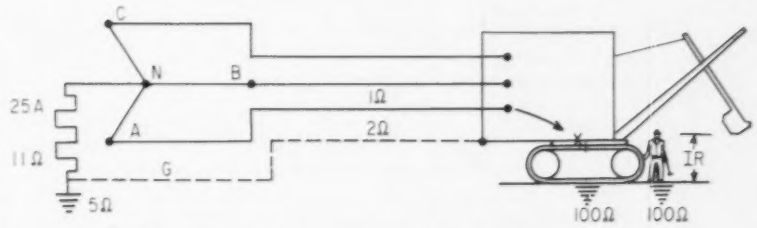


FIG. 2. Principle employed for the 480-v ground-fault protective system.

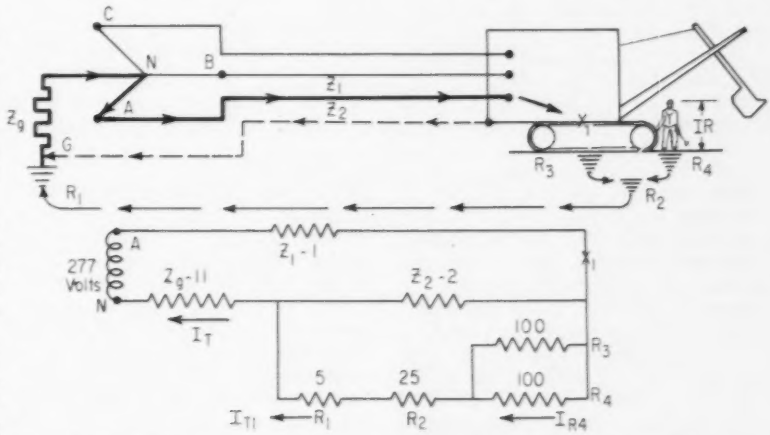


FIG. 3. What happens to a man when he is exposed to a fault at IR.

The principle applied above is that the fault current should be limited to as low a value as possible so as to minimize the arc-weld effect of burning at the time of fault and so as to keep the ground fault voltage to as low a value as possible for personnel protection. However, also this minimum value of current must be of a sufficient value suitable for *positive* operation of the ground relays actuated by the fault current. Quite often this latter point is overlooked in thinking primarily of keeping the fault current to as low a value as possible and it is found that a fault of normal resistance when added to the neutral resistance does not allow a fault current of sufficient capacity to trip off a feeder breaker. Therefore, the breaker will continue latched in and the ground current, though limited to a safe value will continue to flow until either a relay or some other component of the system fails, or the fault either clears itself or becomes solidly grounded with resultant tripping of the breaker. It appears that most manufacturers now agree that the ground current value should not be limited to less than four times the burden required by the current transformer and relay for positive trip of the relay.

The effectiveness of the 480-v current-limiting resistance-grounded fault protective system can be best illustrated by assuming various practical operating conditions and determining the actual voltage a person could be exposed to if in contact with a mobile mining machine.

The contact resistance between the machine treads and earth is indeterminate and usually very high, as proven by test and history over the years. This is contrary to the general impression that the tremendous weight of the machine pressing upon iron ore or wet clay will yield a very minimum resistance as one would normally expect. If good contact resistance cannot be obtained on iron ore it must be higher on other materials such as rock. For our discussion purposes here we will settle on 100 ohms as a fair value for the shovel treads contact resistance. For contact resistance of man to ground 100 ohms is also assumed as a value simply for simplification of explanation and calculation.

Therefore, as a basis of the discussion it should be remembered that the

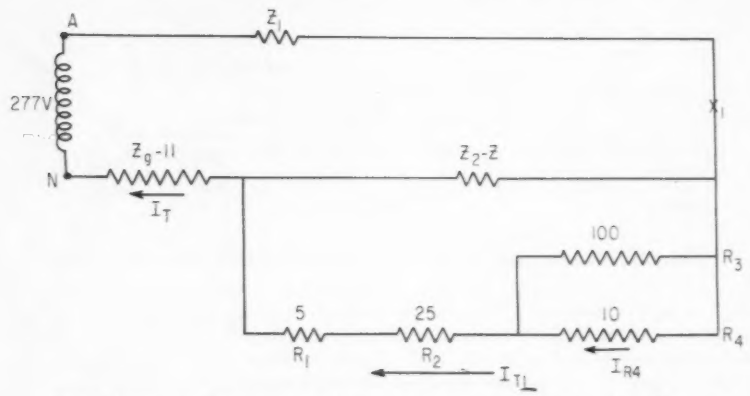


FIG. 4. Impedance diagram with man's resistance estimated to be 10 ohms.

flow of fault current to ground through the high contact resistance causes a high voltage drop or potential difference between that of the machine frame and earth potential. This potential difference is the shock hazard to which personnel is exposed.

Fig. 3 shows the same ground fault protective circuit as Fig. 2 but with a fault at the point XI which could be in the collector rings, cable junction box, motor insulation, etc. and the path of the ground fault currents is emphasized by the heavy lines and arrows indicating direction of flow. Our purpose in examining a fault of this type is to assume an average possible failure of equipment causing a ground fault and to observe the effects upon the man touching the treads of the machine at that time. The voltage drop or potential difference across the man or to which he is exposed is indicated by the figure IR.

At the time of phase to ground fault assuming phase A is at fault, the current flows from A through line conductor to the machine, through the fault X1 to the frame of the machine and returns to the neutral of the transformer, and by two paths. One path is through the metallic ground conductor with the low impedance of a recommended value of less than 2 ohms and the other is through the earth to the station ground network and thence to the transformer neutral to complete this single phase condition. It is noted on the return path to the earth that there is a parallel path at the shovel. One part through the shovel treads contact to ground and the other through the man to ground, combining into a single value of return ground current.

The lower half of the drawing shows the equivalent impedance drawing by which the current paths and the system components are clearly shown and the voltage components calculated. The current flows from A through the line conductor for which the impedance is assumed as 1 ohm, to the fault X1 at which point the current flow splits through the parallel path of the treads and man for which 100 ohms each is assumed as a nominal contact resistance to ground. The contact resistance between the two where they combine to form a single current path is R2 which is assumed to be 25 ohms and thence through the ground to the sub-station ground network R1 of 5 ohms or less where the currents combine through the resistor ZG of 11 ohms through which it returns to the neutral of the transformer. For single phase faults the voltage is 480 v divided by the square root of three, or 277 v to neutral. The parallel paths of 100 ohms leave a common path of 50 ohms which combined with R1 and R2 leaves a total of 80 ohms paralleled with 2 ohms or a common path of 1.95 ohms. The total resistance of the circuit is then 1 plus 1.95 plus 11 or 13.95 ohms. Two hundred seventy-seven divided by 13.95 leaves a total fault current IT of 19.85 amp of which the current IT-1 is 0.484 amp. The current IR-4 through the contact resistance R-4 of the man is then ½ of 0.484 or 0.242 amp and the voltage drop IR is .242 x 100 ohms or 24.2 v to which the man is exposed.

As a person's contact resistance with earth is very indeterminate let us see what happens when the man makes a very good earth contact of 10 ohms and also when he makes a poor contact of 1,000 ohms so that we may see the trend of the shock voltages to which he would be exposed. Fig. 4 shows an equivalent diagram for the man having a 10-ohm resistance and the maximum fault current IR-4 through the man is 0.882 amp which times 10 ohms gives an IR drop or potential difference to which the man is exposed of 8.82 v.

Fig. 5 is the equivalent impedance diagram for when the man has resistance of 1,000 ohms and the current IR-4 becomes 0.0293 amp which times the man's 1,000 ohm resistance is a potential difference of 29.3 v.

Therefore, it can be seen with all other system components remaining the same the shock hazard to man increases as his contact resistance to earth becomes greater. In each case, however, the maximum voltage to which the man could be exposed would be the product of the maximum pre-determined current of 25 amp times the maximum allowable resistance of 2 ohms for the ground return path or 50 v which is considered to be a reasonably safe voltage for accidental exposure of man. Therefore, it should be again emphasized that the key to the entire scheme is keeping the maximum resistance of the metallic ground return path to the under 2-ohm value so that when combined with the maximum allowable ground fault current a hazardous voltage will not be developed.

On the basis of the above it now appears that we have practically a foolproof scheme, providing it is installed and maintained properly, by which personnel can be protected against shock hazard voltages at the time of any phase failure to ground.

However, we still have the simultaneous double ground fault to contend with as shown in Fig. 6. This is a case where we have the failure at point X1 on phase "A" and have a simultaneous failure at point X2 on phase "B" of the cable or cable junction box in the field, etc., which causes a dead short circuit across the phase "AB" impressing 480 volts on the system. The current flows from point "A" through the line conductor and fault X1 through the metallic ground return path to phase "B" and also by parallel paths through the machine treads and the man back through contact resistance R-1 at fault X2 to phase "B."

The equivalent diagram of this circuit is shown below and in this case the total fault current IT becomes 121.5 amp with a current of IR-4 through the man of 1.22 amp which times his 100 ohms resistance gives 122 v of severe shock hazard. In accordance with the problem before, as the man's resistance increases, the voltage increases and the shock hazard becomes more severe.

It is expressly desired to bring this point out, of the hazard due to simul-

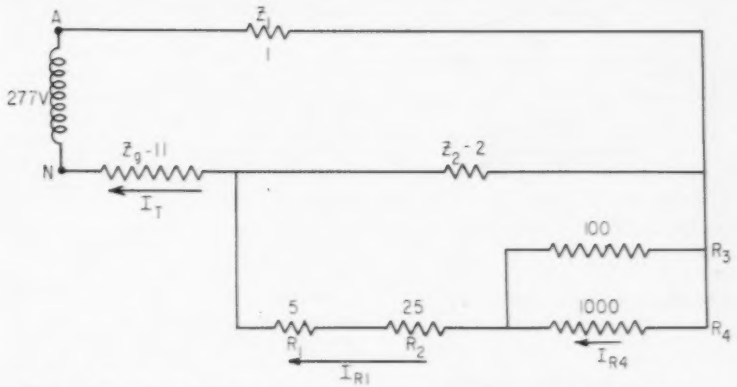


FIG. 5. Impedance diagram if man's resistance is estimated to be 1,000 ohms.

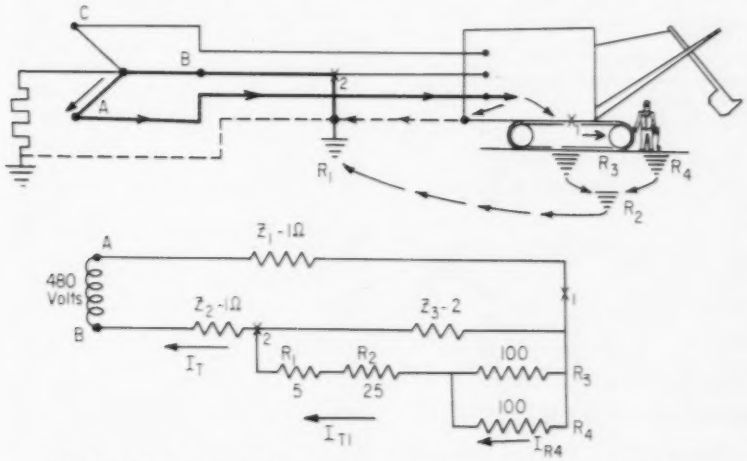


FIG. 6. What happens when we have simultaneously fault at X_2 and X_1.

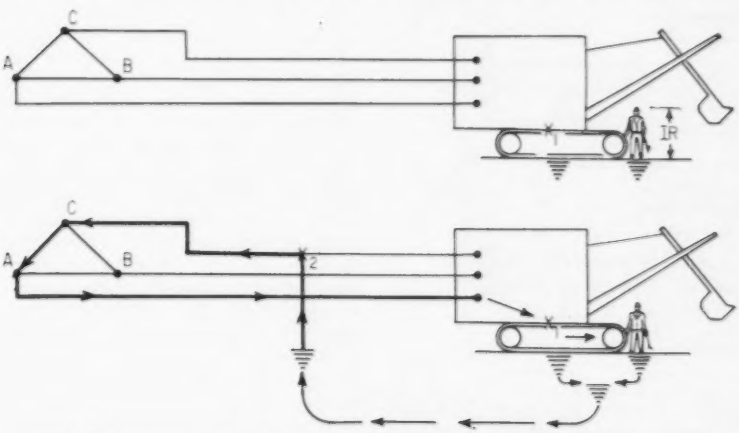


FIG. 7 In a case such as this the man would not be exposed to any hazard.

taneous double ground fault, as with the 480-v ground fault protective systems and component parts, such as type "G" cable, there is no protection for personnel against this type of fault other than a good constitution. Type "G" cable, of course, is a three-conductor, unshielded with three ground wires in the interstices. However, it does appear that this hazard could be considerably minimized by providing type SHD cables, where each conductor is individually shielded and grounded to the three ground wires in the interstices of the cable.

It is known the greatest percentage of faults occur in the cable rather than on the machine, and if the insulation of one phase conductor is injured and the current cannot find its path to the adjacent ground conductor, it does develop a circuit with earth but possibly of not sufficient amount to trip the ground fault protective breaker because of the current limiting effect of the high resistant fault. This, then, sets the stage for the double ground fault, which may occur at any time, due to a second phase becoming grounded anywhere on the system. The type SHD cable is a standard for the high voltage ground fault protective system and a simultaneous double ground fault on a high voltage system is a rarity, as any conductor fault current must pass through the conductor shielding before making contact with earth or any other conductor. The sensitivity and speed of the ground fault equipment is usually sufficient to take the circuit off the line before severe hazard can occur.

It is wished to emphasize that the suggestion of the 480-v shielded cable under similar conditions as that used in the high voltage field is not a cure-all or a preventative of the simultaneous double ground fault but will tend to considerably minimize the hazard as has been proven in high voltage use.

Now that the worth of the current-limiting resistance-grounded fault system has been established, it might be well to examine other varieties of the ungrounded and grounded systems to explore the possible hazards of each. Fig. 7 shows an ungrounded 480-v delta system, to which a man leaning against a shovel is exposed. If any of the phases A, B or C should become grounded, such as at point X1, the potential of that phase immediately becomes the same as that of the earth and a man is not exposed to any hazard.

There is no current flow as, theoretically, there is no way for the current to get back to the transformer windings, so, therefore, there can be no IR drop or potential difference across the man. However, as explained earlier, there is a possibility of a charging current to which the man could be exposed, which could cause an indeterminate IR drop at that time.

The lower diagram shows phase "A" faulted at point X1 and later a fault developing at point X2 on phase "C' and thus impressing the full 480-v phase voltage CA across the man paralleled with the machine. In that case, a man is subjected to severe hazard.

Let us examine this problem, as

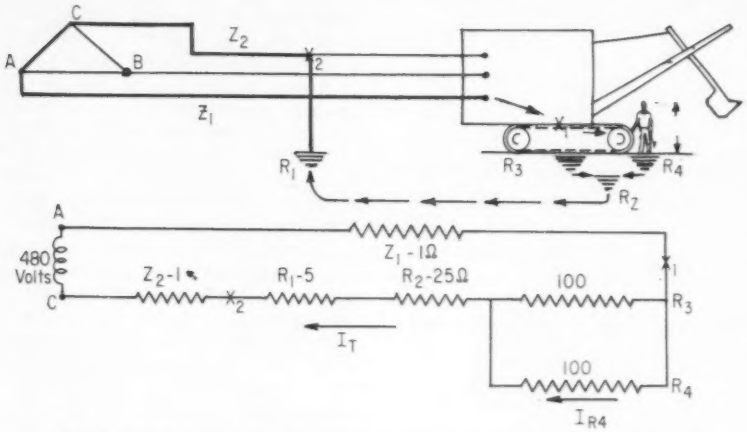


FIG. 8. But in a case such as this, man would be exposed to severe hazard.

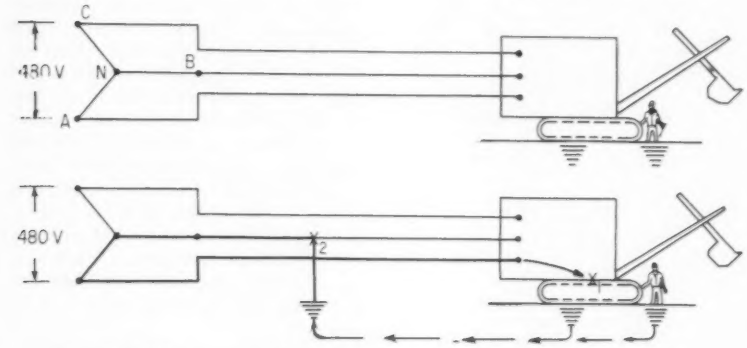


FIG. 9. Effects would be same for ungrounded wye-system as for delta.

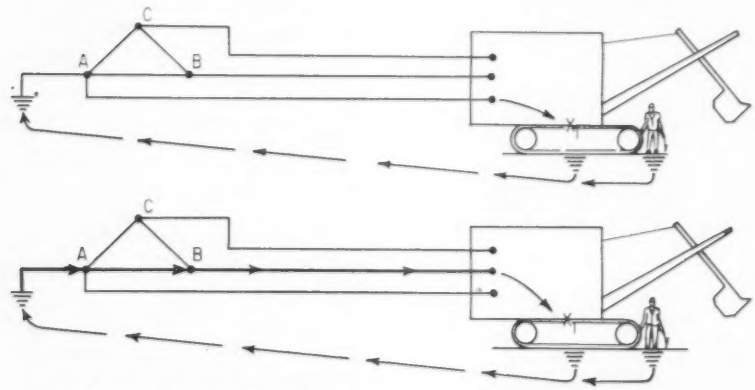


FIG. 10. If phase B should become grounded, watch out for injuries.

shown in Fig. 8, with its equivalent impedance diagram. Assuming the same values as we have used in the earlier calculations with R1 being assumed as a contact resistance of approximately 5 ohms and the line conductors as 1 ohm each, the total fault current IT becomes 5.85 amp. The current through the man is ½ of the parallel path or 2.93 amp, which times 100 ohms yields 293 v across the man. In this case, as in the earlier examples, as a man's resistance to ground becomes greater, the shock hazard becomes greater. With the balance of the components remaining the same, at 10 ohms the voltage across the man is 174.5 v and at 1,000 ohms the voltage is 355.

This system has been and still is extensively used because of the reason that the single fault theoretically does not cause a hazard to man and production is not interrupted because of outage of equipment. *However, the theory lives only on borrowed time because the time and condition of the second fault is unpredictable and may occur at any time, thus causing the severe shock hazard outlined above.*

Fig. 9 shows the ungrounded 480-v wye system which has the identical effects of the previous ungrounded delta system.

Fig. 10 shows the grounded 480-v delta system whereas with a fault on phase "A" there is no harmful effect on man, as he is at the same potential as phase "A" which is grounded. However, if phase "B" should become grounded, a man is exposed to the full 480 voltage of phase **AB**, as shown in the lower part of the diagram. This also goes for phase "C."

If a simultaneous ground fault should occur on phases "A" and "B" as shown in Fig. 11, the equivalent diagram proves out that the maximum fault current would be 15.65 amp with the maximum current IR-4 of only 0.48, which times 100 would yield 48 v. Of course, the shock hazard increases with the man's resistance to ground. The saving feature of this particular circuit is the low impedance of the less than 5-ohm substation ground bus.

However, if the man should have hold of the cable, as in Fig. 12, he would be in the unfortunate position of having all of the fault current pass ing through him of 4.55 amp which times 100 ohms is 455 v. Thus by picking up a faulted cable with, let's say a bare conductor, the man would complete the circuit with an already grounded phase and *would be instantly killed.* This again advances the argument for the type SHD cable for the 480-v service and it is hoped that more engineers will be able to see their way clear to promote this principle. For the open pit mining application it is primarily an economic consideration, though upon investigation, it is only 20 to 25% more costly than the type "G." For underground shuttle car installations, etc., there is the additional necessity of flexibility to be considered. It cannot be said that the underground cable receives more abuse than the other as it is certain that both types receive plenty of abuse in service.

Fig. 13 shows a double fault on phases B and C in which again the man is subject to the full 480 v. If the man were located at fault X-2, he would be subjected to additional current effects from phase CA as shown by the equivalent diagram.

Fig. 14 shows a solidly grounded wye system which at the time of any

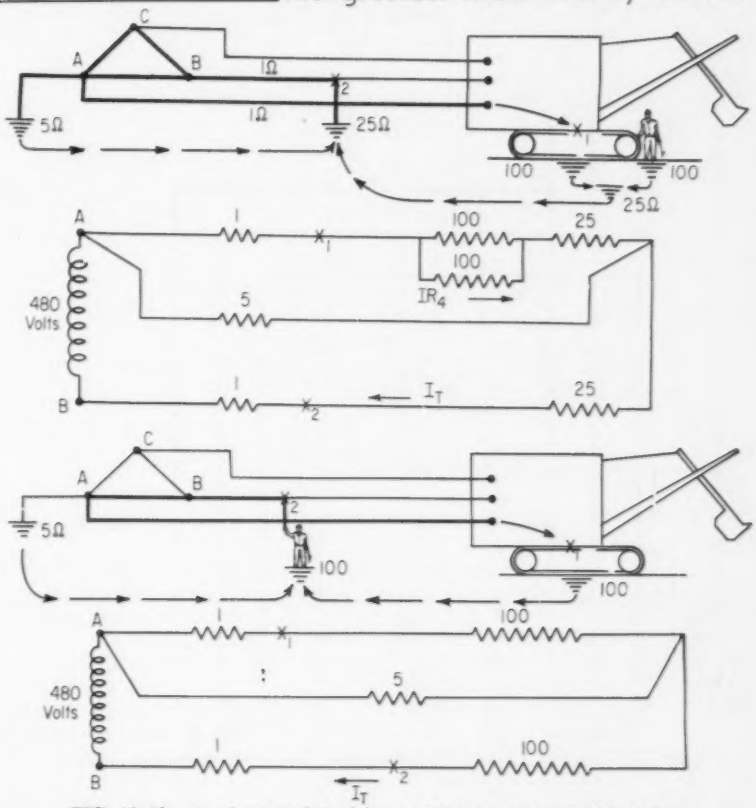


FIG. 11. Conditions governing a simultaneous double ground fault.

fault on phases A, B or C, the man would be subjected to a phase to neutral voltage of 277 v and be subjected to the shock hazard of 171 v. Thus we are again back to the current - limited resistance - grounded fault protective system as the most ideal system, the serviceability of which can be improved by the addition of type SHD cables in place of type G for minimization of hazards due to simultaneous double ground faults.

Now let us look at the types of equipment that are available to make the current-limited resistance-grounded fault protective system operable. Fig. 15 shows a General Electric system of a double unit consisting of two breakers, one for each load, neutral ground wire returns to the system through a current limiting resistor to a zigzag grounding transformer, in this instance, which derives the system neutral. The neutral ground fault current is limited to 5 amp which divided into 277 v makes the resistors a total of 55 ohms. The trip elements are the relay coils inserted in series with the ground wire and designated as 51-1 and 51-2. The breakers are opened on ground fault by the shunt trip coil 52. The normally open contact 52 closes as the breaker closes and when the normally open contact 51 closes when energized by relay 51, coil 52 is energized thus tripping the breaker.

Relay 51 is a ½ to 2-amp relay and operates in one cycle at twice rated or one ampere. The one cycle relay combined with the one cycle moulded case breaker is a 2-cycle trip operation which is very good. However, the sensitivity of the circuit by being limited to 5 amp could be too great at times as the high resistance cable fault could possibly introduce enough resistance into the fault return circuit to make a positive trip action of the relay under all conditions doubtful. For that reason, it may be desirable to raise this ground return current to 25 amp so as to get positive action under all conditions. The relay now used is good for 35 amp for one second which is 30 times its tripping requirement so therefore has adequate capacity. It is realized that there are other certain limitations that may be involved such as the current rating and, consequently, the size of the

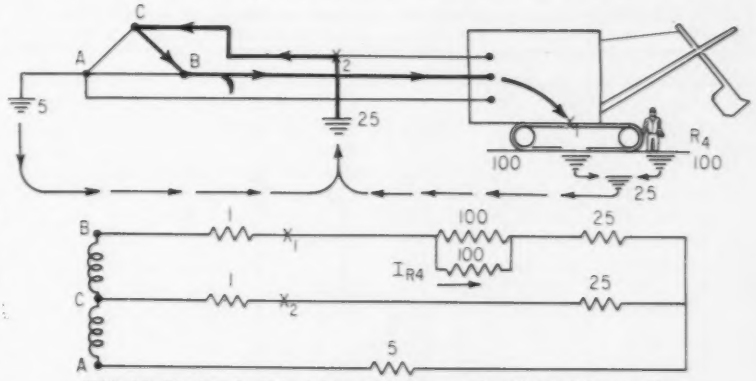


FIG. 12. If a man happened to pick up a cable here, he would be killed.

FIG. 13. Double fault in this case poses a serious hazard for worker.

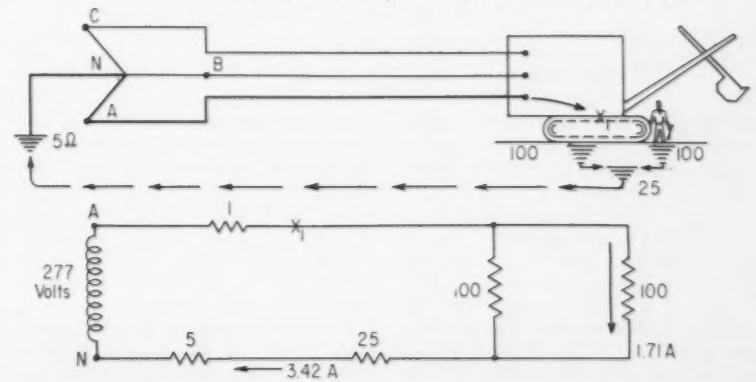


FIG. 14. A shock hazard of 171 v exists for the man in this setup.

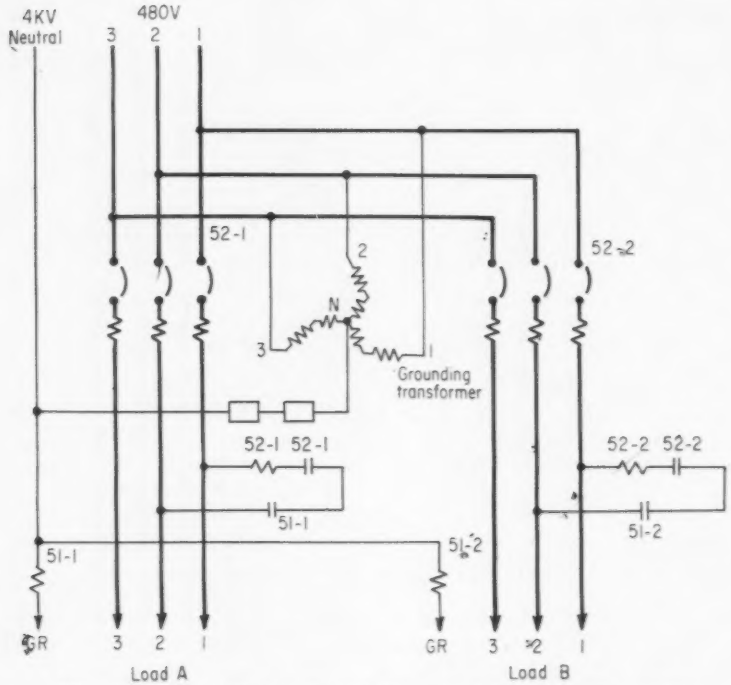


FIG. 15. General Electric Co.'s 480-v ground fault protective system.

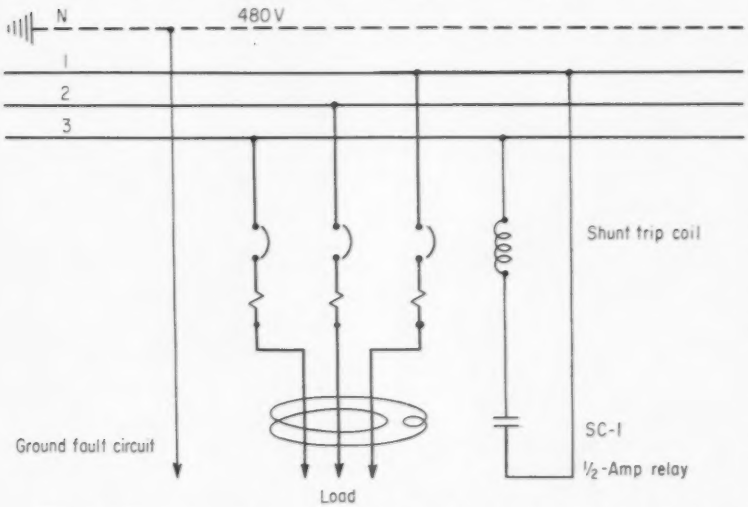


FIG. 16. Westinghouse ground-fault protective system for 480-v installations.

zigzag grounding transformer. However, if a straight wye connected power transformer is used, this problem is eliminated.

There is also the possibility of a low resistance ground return due to pump pipeline providing a parallel path to the ground conductor and thus by-passing enough current from the metallic circuit to the relay to make the relay inoperable. This could be provided against by moving the 51 relay from the individual breaker lead to the main neutral lead just preceding the neutral resistors. However, this would destroy the selectivity of the circuit as it would have to be used to operate a main breaker ahead of several feeder breakers and thus dump all circuits at the time of a ground fault on any one feeder.

In either case of the high resistance fault circuit or the by-passed relay circuit, the system would fail safe inasmuch as the fault current would have to return through the current limiting resistors and thus maintain the system at a safe voltage. Again, there is always a hazard of failure of some component of the ground return system such as the resistor, grounding transformer, etc., caused by the continuous current. At that time of failure, of course, a hazard would exist due to the opening of the return ground current path.

Fig. 16 shows a Westinghouse Electric Corp., 480-v protective ground fault circuit. In this case, a shunt trip coil is used, actuated by a ½ to 2-amp relay similar to that of the above described of the G. E. Co. The relay is actuated by a through type current transformer which takes approximately nine amperes of fault current for a ½-amp output. Therefore, it is most essential to go to a minimum of 25 amp for ground fault current limit. In this case, the current limiting resistor is not shown as the circuit originates back at the transformer.

The ground fault protective circuit used by Joy Mfg. Co. is as shown in Fig. 17. The creation of a fault to ground on the machine frame will produce an unbalanced condition resulting in an induced voltage in the rectifier winding. This voltage will be rectified and result in the operation of the sensitive relay, SA, causing the undervoltage release circuit to be opened. This will open the breaker feeding the affected machine and remove it from the line. In turn, the ground fault is removed, giving the machine operator quick, positive protection. The advantage of this undervoltage trip is that it is not dependent upon the ac voltage to actuate the breaker operating coil as the ac voltage may be nonexistent at times because of its having been pulled to theoretical zero at time of fault.

The through type transformer requires 7½ amp for ½-amp output for the relay circuit. Quite often the ground fault current will be limited to 10 amp which does not give a sufficient range between the minimum pick-up value of 7½ and the maximum limited value of 10 amp so that, at times of high or medium high resistance cable fault the circuit will not trip and the cable sizzles and arcs until it fires with resultant excessive damage. Here again the current limiting value should be set at approximately four times minimum pickup, or approximately 25 amp so as to insure positive action.

At present time of failure to trip because of high resistance cable fault

the system fails safe because of its current limiting action but if the fault should remain on the system very long and any component of the current limiting system should fail, again all protection is lost and personnel is subjected to extreme hazard.

One of the biggest advantages of this system is the test circuit built into the toroidal wound current transformer so that by pressing a button on the unit the operating circuit can be energized and tripped under simulated fault condition.

The grounding of portable mining machines can be a hazard instead of a safeguard if the fault protective equipment is not properly installed and maintained. The following precautions should be observed in the operation and maintenance of a ground fault protective system.

1. The ground fault protective system should be checked periodically for positive operation.
2. The ground wire should always be the first lead connected whenever a power cable is re-connected to the system, and conversely, should always be the last to be disconnected when removing a cable from the circuit.
3. All ground wire connections should be carefully checked for good and proper connection at each time a power cable is changed.
4. Ground wires carried in portable power cables should be checked regularly for continuity.
5. Ground network should be checked periodically under various conditions to assure a continuing low resistance which is so essential to proper operation of the ground fault protective system.
6. Faulty portable power cables should be permanently repaired with vulcanized splice as soon as possible.

In conclusion, it appears from the foregoing discussion that the current-limiting ground fault protective system for the 480-v portable equipment is a "must" in today's story of productivity.

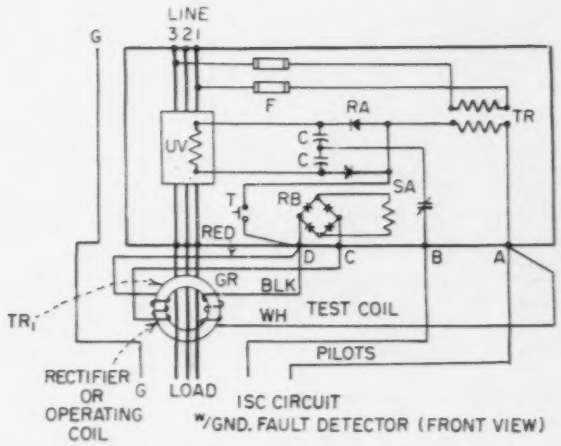


FIG. 17. Joy Mfg. Co. ground-fault protective system for a 480-v power system.

In the first place, the life of the workman is assured within the maximum limit of protection that engineering "know-how" can provide. This is the first law of the United States Gypsum Company and it is certain that it is the prime consideration in the minds of management of other companies whether they have the ground fault protective system or not. Additional information such as contained in the above discussion allows management to make a new evaluation and to assess the protective equipment's value as to the safety provided for the personnel versus the calculated risk due to economic considerations.

In the second place, the current-limiting ground fault protective system reduces damage at time of insulation failure to an almost negligible amount, in direct opposition to the ungrounded or solidly grounded system with its almost unlimited ground fault current and its arc weld burning effect at the point of fault.

Isolation of the faulted machine is provided, thus automatically shutting down only the faulted machine and not the entire mining operation with its resultant total lost time production until the faulted feeder is located and disconnected from the system.

The danger of fire is eliminated, provided the circuit will trip automatically by allowing enough of the safe value of the fault current to flow to trip the circuit breaker.

It is strongly urged that each proposed ground fault protective system be carefully engineered to suit the specific application including the fullest consideration of its operation under the most adverse conditions.

Recent Power Articles for Your Mine Reference Library

"New Controls Cut Costly Downtime on Crushers and Grinding Mills." H. A. Wright. *E&MJ*, October 1957, p 94. A new combination of relays protects large mill equipment against the overloads produced by intermittent surges of feed to large crushers and other mill units.

"Preventive Maintenance for Mine Power Cables." *E&MJ*, June 1957, p 102. Mine electricians are advised to test mine cables regularly with megohmmeters to detect signs of insulation deterioration which could cause short circuits and mine shutdowns. Cables require scheduled maintenance just as other machines and equipment do.

"Progress in Motor Design for Mining." *E&MJ Guidebook*, Mid-June, 1957, p 124. A survey of what modern motor manufacturers are incorporating in new designs for mines, mills and smelters.

"Star Mine Fights Rising Costs With New Adit and Equipment." W. E. Crandall. *E&MJ*, January 1957, p 86. New 13,000-v power transmission and distribution equipment resulted in substantial power savings expressed in cost-per-ton at the Star mine of the Hecla Mining Co.

"Trailer-Mounted Diesel Generating Plants Deliver 675-Kw." *E&MJ*, May 1957, p 35.

"Mobile Unit Power at Anaconda's Jackpile Mine." *E&MJ*, March 1957, p 75. Where electric shovels are a long way from a power source, it is more economical to feed power to the shovel with a mobile diesel-electric generating unit, than to mount the diesel-electric equipment on the shovel, and thereby increase the deadweight that must be swung around during the shovel loading cycle.

"Gunnar Makes Power All Year 'Round." *E&MJ*, December 1957, p 100. Details of a dependable 5,070-kw diesel-electric plant.

"New Ground-Fault Protection Safeguards Open-Pit Workers." I. L. Boyum, *E&MJ*, August 1956, p 94.

Choosing Scales for Mine Operations

Lever Action Scales

Co.	No.	Capacity	Type	Location and general application	Recording
A	1	60-ton	Truck	Regular truck scales for weighing concentrate shipments.	
B	1	50-ton	Truck	Mine—weighs ore trucks;	Records manually.
	1	50-ton	Truck	Plant—weighs nodule trucks.	
C	4	150-ton	Track	Surf. std. railroad cars.	Hand-operated ticket printers.
	1	100-ton	Track	Surf. std. railroad cars.	Hand-operated ticket printers.
	3	30-ton	Track	Underground mine cars.	Electronic trip and strip printers.
	1	30-ton	Truck	Surface trucks.	Hand-operated ticket printer.
	1	25-ton	Truck	Surface trucks.	Hand-operated ticket printer.
	5	20-ton	Truck	Surface trucks.	Hand-operated ticket printer.
D	1	25-ton	Truck	For weighing truck loads of concentrate.	
E	1	10-ton		Concentrate is loaded into containers and weighed by this scale.	Manually operated.
F	1	20-ton	Truck	Receiving bin—sample mill—lead smelter.	
	1	150-ton	Track	Receiving bin—lead smelter.	
	1	150-ton	Track	Receiving bin—lead smelter.	
G	1	150-ton	Track	Triple plant R.R.—weighs railroad cars.	Printer.
	1	125-ton	Track	Dry mill R.R.—weighs railroad cars.	Printer.
	1	100-ton	Truck	Triple plant—weighs trucks.	Printer.
H	1	25-ton	Truck	Located near storage yard for weighing heavy material.	No recording.
	1	½-ton	Platform		Recording.
	1	¾-ton	Platform		Recording.
I	1	50-ton	Truck	Mill office—weighing ore trucks in and concentrate trucks out.	
L	1	50-ton	Truck	Mill—weighing ore trucks from mine.	Equipped with manually operated recording device.
M	1	125-ton	Track	Stock bin scales. Smelter. Used to weigh incoming concentrates, outgoing concentrates; also custom ore and concentrates and inter department materials.	
	1	125-ton	Track	Hi-line scales. Smelter. Used for weighing ore.	Recorder.
	1	125-ton	Track	Used for weighing ore and incoming materials. Also for commercial use.	
	1	150-ton	Track	Manganese nodulizing plant. Used to weigh finished manganese nodules for shipment to customers.	

WHAT SCALE will do the best job for your mine? *E&MJ* recently asked 18 metal and nonmetallic mining companies for the type of scales they used at mines, mills and smelters.

The tables which accompany this article contain the answer. They list use of lever action scales by 14 operators and conveyor belt weighing instruments by 15 reporting companies. One company alone reported a total of 34 scales—27 conveyor type and seven lever action.

The mine, mill and smelter operator uses the scale to measure output from his property—output per shift, per man, per month, per hour and day must all be based on some reliable scale.

Much processing equipment requires a consistent and constant flow of ore or material for efficient operation. Here the scale is a guide to the mill- or smelter-man to keep his portion of the plant at peak productivity. Again, moisture content or lack of it must also be watched carefully.

In the modern mineral processing plant, the trend toward automatic batching of materials is increasing. The scale plays as important a role here as in the continuous process.

As the conveyor scale performs in individual positions within the mine and plant, the lever action truck and track scale provides information at the two ends of mineral production.

The amount of ore and waste from a mine, underground or open pit, is the constant guide for the mine superintendent. Planning future operation, establishing expansion goals, scheduling of equipment and labor, all require a knowledge of volume to be handled. So, too, the final product for market must be scheduled, loaded and routed efficiently.

The *E&MJ* survey covers the following number and type of scales:

Conveyor belt scales		100
Lever action scales		
Truck	21	
Track	26	
Platform	3	
Other	3	
Total		53

Use of Lever Action

Size of the scales employed by the 18 reporting firms ranged across the scale from 30,500-lb units to 100-ton installations. Most popular of the 21 used in truck weighing was the 20-ton capacity scale, which was reported in use at six different plants.

Number of truck scales in use

order of popularity ranked about as follows: 50-ton scales, four; 25-ton capacity, three; 24-ton units, two. It must be noted that the 18 companies surveyed ranked in size from large copper and ferroalloy producers to smaller producers of base metals.

The larger sizes of track scales also dominated the results of the survey. Of the 26 track applications noted, 10 were of 125-ton capacity and nine were 150-tons. Three 100-ton scales also were reported, as were three 30-ton units and one 20-ton.

The three platform-type scales reported in the lever action scale group were of 1,000-, 1,500- and 2,500-lb capacity, respectively.

Truck Scale Accuracy

Since most mining trucks are employed in off-highway jobs, the industry is not so greatly concerned with state and local regulations for maximum allowable loads as are truck fleet operators. However, the magazine *Fleet Owner*, in a discussion of truck weighing, makes some points which can help the mine and mill man concerned with accurate truck weighing procedure. These points are based on work by the National Conference on Weights and Measures, an association of state and local weights and measures officials from all parts of the U. S. The group's objectives are to promote uniformity of laws, regulations, equipment and methods.

In setting standards for weighing procedure, the conference recommends the following:

1. A weighing device should first be balanced to register zero with no load on the platform.
2. It should be inspected to insure that during weighing it is not subject to interference or excessive friction.
3. It should be tested periodically by a weighing authority.
4. During weighing, the load should be entirely and alone on the scale, and not in contact with other structures.
5. Allowance should be made for the effects of wind pressure on the load; for accumulation of ice and snow and mud; for inherent instrument errors, variations or balance changes.
6. A written record should be made of the weighing.

Of the 53 lever action scales reported in the survey of 18 mining companies, 16 were operated manually, 18 were equipped with some sort of mechanical recording device, and 19 respondents did not indicate how records were kept in their particular instance.

The use of electronic, constant motion recording instruments is be-

Lever Action Scales *(Continued)*

Co.	No.	Capacity	Type	Location and general application	Recording
	1	125-ton	Track	Used for weighing ore, slum, other ores mined.	
	1	100-ton	Track	Sampler office scales. Used for weighing custom ore.	
	1	100-ton	Track	Sampler mill scales. Used to weigh custom ore after sample is taken out; also for the purpose of keeping weight within load limit.	
	1	20-ton	Track	Warehouse. Used for weighing heavy material such as wire rope, rubber belt, steel and pipe; also for making shipments.	
	1	18¼-ton	Truck	Salvage dept. Used to weigh scrap metal, wood, phosphate and phosphoric acid. All departments use this scale for weighing.	Type registering.
	1	15¼-ton	Truck	Used to weigh ferro manganese in small batches (boats) and is then loaded into larger cars for shipment to customers.	Type registering.
	1	24-ton	Truck	Brick yard scales. Used for weighing clay for the manufacture of brick; scrap material for foundry; also for large trucks for checking load limits.	Type registering.
	1	24-ton	Truck	Used for weighing custom ore brought in trucks.	Type registering.
	1	150-ton	Track	Smelter. Weighs calcine, limerock, ore and arsenic.	Type registering.
N	4	125-ton	Track	Railroad scales used for loading railroad box cars.	
	1	125-ton	Track	Mine car scale for mine ore weights. Located approximately 1,000 ft underground in the mine.	Tape printing attachment.
	2	200 lb		Bagging plant checkweigh scales.	Tape printing attachment and reject mechanism for underweight and overweight bags.
O	1	2,500 lb.	Platform	In mill to weigh grinding balls for ball mills.	
P	1	50-ton	Truck	At mill for weighing crude mine ore and concentrates.	Electronic recording device.

Conveyor Belt Scales

Co.	No.	Capacity	Location and general application	Recording
A	2		Weighing ore feed to ball mill.	Automatic dial recorders.
B	1	50 tph	Weighs flotation concentrate fed to kilns.	
	1	100 tph	Weighs nodules produced in kilns.	
	1	200 tph	Weighs crushed ore fed to mill bins.	
C	10	50–1,000 tph	Used for weighing crushed mine ore and in one case for weighing table tailings.	Equipped with dial recorders.

Conveyor Belt Scales (continued) . . .

Co.	No.	Capacity	Location and general application	Recording
	1	150 tph	Used for regulating crushed ore feed to rod mill.	Equipped with dial recorder.
D	1	100 tph	For weighing mill feed.	Mechanical recording device.
E	2	78 tph	Weighing feed to ball mills.	
F	1		Tailing scale in mill.	Recording device.
	1	150 tph	Main feed scale to mill.	
	1	150 tph	Feed to bedding plant smelter.	
	1	4,000 lb.	Smelter Lead Ref: Casting.	Automatic teleprint.
G	2	17 tph	Reaction feed control and record.	Electronic and pneumatic.
	2	5 tph	Reaction feed control and record.	Electronic and pneumatic.
	1	35 tph	Records production.	Mechanical.
	3	100 tph	Records production.	Mechanical.
H	14	150 tph	Used for weighing ore.	Recording, integrating type.
	1	2,300 tph	Used for weighing ore.	Recording, integrating type.
	1	1,500 tph	Used for weighing ore.	Recording, integrating type.
	1	300 tph	Used for weighing ore.	Recording, integrating type.
J	2	350 tph	Mine. Ore size 24 in. to 30 in. max. 5 min.	Log rateograph.
	1	64–170 tph	Crusher. Ore size 3 in. max. 1 min.	Log rateograph.
	1	13.5–40 tph	Light ash—20 mesh 1 min.	Log rateograph.
	2	16–48 tph	Dissolving—20 mesh 1 min.	Log rateograph.
K	7	2,500 lb.	Weigh material before it goes on conveyor belt which feeds electric furnace.	Each equipped with recording device and electronic controls.
L	2	25 tph	Measuring ore feed to mills.	Recording device.
M	1	20 tph	Phosphate roaster. Superphosphate from furnace building to sacking station.	Recording device.
	1	900 tph	Sample mill. Used to weigh the copper ore from car dumper.	Recording device.
	1	25 tph	Zinc concentrator. Belt conveys zinc concentrates to cars to roaster.	
	1	65 tph	Filter plant. In tunnel between filter and roaster feed from filters to roaster for furnaces.	Recording device.
	1	800 tph	Conveyor takes ore from shaft to storage bins to then be loaded in cars to be taken to the crushing plant.	Recording device
	1	2,400 tph	Used for weighing ore at crushing plant.	Electronic.
	1	2,400 tph	Used for a check weight on No. 3 belt where the first scale is located—to determine moisture loss, etc.	Electronic.
	1	4,000 tph	Used to check weight of ore over No. 3 belt.	Electronic and air.
N	27	0–1–0–500 tph	Used as operating aids or for production in both the mine and the refinery.	26 are recorders; 4 are automatic controllers, 17 have totalizers, 7 indicate or record at more than one point and 26 have the indicator or recorder remote from the conveyor where the weigh frame is located.
O	1	70 tph	In mill to weigh ore feed to rod mill.	Equipped with recorder showing scale loading.
P	1	20 tph	In mill weighing ball mill feed.	Recording device.

coming common in the lever action scale side of the mining industry, as it has already done in the conveyor belt scale use. In the latter case the use of continuous recording is expanded to integrate it with other record keeping practices in the plant.

Conveyor Belt Scales

Of the 100 conveyor belt scales reported in the survey, 91 were equipped with some recording device and nine operators did not provide information on the type of record keeping they employed.

The importance of conveyor weighing is indicated by this comment from the chief instrument engineer of a large mining company:

"You will doubtless recognize that we use conveyor scales much as flow meters are used in the fluid process industries. Operators need to know how much comes in and how much comes out, whether it's in a pipe or on a belt. The remarkable advantage of using scales in this manner is just beginning to be appreciated. It's a wide open field."

The breakdowns of scale application in the tables which accompany this article will give you a clear guide to capacities used, placement and purpose in some of this country's leading mines and mills.

E&MJ is indebted to the following mines and their operating personnel for the information which comprises this article, and which they graciously made available.

Davison Chemical Co., Florida Phosphate Div., Bartow, Fla.

Howe Sound Co., Holden, Wash.

Wah Chang Mining Corp., Lincoln Mines, Div., Tempiute, Nev.

Manganese, Inc., Henderson, Nev.

St. Joseph Lead Co., Bonne Terre, Mo.

Minerals Engineering Co., Montana Tungsten Div., Glen, Mont.

Anaconda Co., Anaconda, Mont.

Banner Mining Co., Tucson, Ariz.

Kings Mountain Mica Co., Inc., Kings Mountain, N. C.

Sunshine Mining Co., Kellogg, Idaho

American Smelting & Refining Co., Colville, Wash.

Bunker Hill Co., Kellogg, Idaho

Monsanto Chemical Co., Inorganic Chemical Div., Monsanto, Idaho

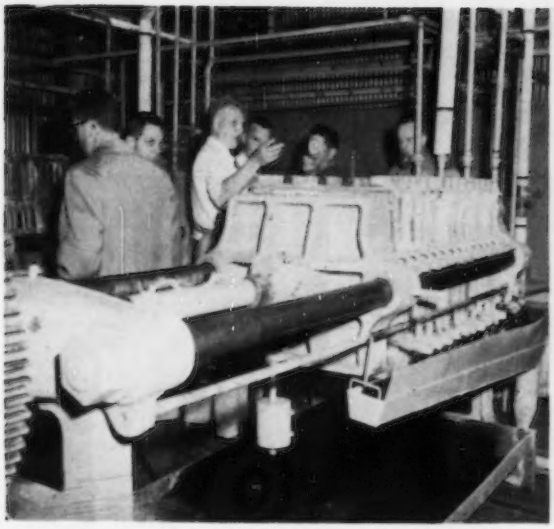
Hidden Splendor Mining Co., Grand Junction, Colo.

Climax Molybdenum Co., Climax, Colo.

Potash Company of America, Carlsbad, N. M.

International Chemical Co., Chlor-Alkali Div., Food Machinery and Chemical Corp., Green River, Wyo.

Idarado Mining Co., Ouray, Colo.



EQUIPMENT used by another plant to solve a problem may be what you need to solve your mineral processing problem.

LATE developments, new techniques call for constant review and, if necessary, revision to bring a flowsheet up to date.

Processing Solutions and Results — Guides to Your Mineral Problem

FLOWSHEETS, with their step-by-step solution to a mineral processing problem, present the complete approach to a problem in a neat, concise package. They can substitute for a plant visit.

Every mineral deposit presents an individual processing problem—seldom is one package-process used to recover the same metal or mineral from similar ores. But the manner in which one metallurgist or company solved a particular problem will give you clues to getting the results you want.

The following 31 pages of flowsheets are based on this problem, solution and results formula. A problem—how to handle Blackbird's cobalt concentrate at Howe Sound. Solution is the new electrolytic flowsheet shown in this article. The results are stated in every case, as are the original sources of the information on which the flowsheets are based. Some of these flowsheets have never before been published in *E&MJ*. Some have come from recent American Institute of Mining, Metallurgical & Petroleum Engineers meetings, and others from back issues of *E&MJ* and the Canadian Department of Mines.

The following flowsheets are included in this 1958 Mid-June Mining Guidebook:

Pima Mining Co.'s chalcopyrite flotation
Jones & Laughlin's Hill Annex tailings flotation
Marquette Iron Mining Co.'s jasper flotation
Sherritt Gordon's cobalt process
Swedish hematite flotation pilot plant
Calera's new electrolytic cobalt refinery
Sherritt Gordon's ammonia leach for nickel
Chlorination of mixed sulphides at Mitterberg
Using acetone to extract uranium (patent)
Flotation of mercury at Bretz mine
Recovering and refining rhenium (patent)
Concentrating phosphate on belts at Coronet
Metal & Thermit's new rutile-ilmenite concentrator
Resin-in-pulp at Uranium Reduction Co.
Cyanide for gold at Belleterre, Quebec
Column ion exchange at Dawn Mining Co.
Anaconda Co.'s cadmium refinery
Bismuth production at Oroya
Producing electrolytic chromium (patent)
Udy Processes for iron and ferromanganese
How Boliden smelts copper and lead ores
Producing lithium hydroxide at Bessemer City, N. C.
How Deloro smelts silver and cobalt ores
Vitro Uranium Co.'s solvent extraction mill
Heavy Media Separation on Virginia manganese
Bicroft Uranium's milling of a uranium pegmatite
International Nickel Co.—how the smelter grew in complexity—and how Inco produces electrolytic nickel from low-copper nickel matte anodes
How Gorno mine floats oxidized lead and zinc

In addition to these, *E&MJ* published a 16-page "Flowsheet Design Book" in December 1957. It contains 13 additional flowsheets, none of which are repeated here. For flowsheets published in previous Mid-June Mining Guidebooks, see the index in the front of this issue.

There are two other recent *E&MJ* sources of flowsheets and processing data—"Electrons and Ions" and "Industry Looks at Direct Reduction." Electrons and Ions discusses the whole range of mineral processing, based on the action of the ions and electrons. Direct Reduction is a review of those direct reduction processes now being considered for iron and steel production. Reprints of all three of these articles may be obtained from the Reprint Editor, *Engineering & Mining Journal*, 330 West 42 St., New York 36, N. Y.

You can obtain these reprints to keep with your 1958 edition of the Mid-June Mining Guidebook, and past Guidebooks. Such a package will provide you with readily available information on over 65 modern mineral processes, and the latest developments in some 50 different processes now in use or under investigation.

Metal and Mineral Processing

THESE ARE THE METALS		Rare Earth	Rare	Radioactive	WITH DENSITIES (LB/FT³)	WITH THESE ABUNDANCES In The Earth (PPM) [1]	In The Sea (PPM) [1]	IN THE FORMS OF THESE ORES OR MINERALS	IN THESE CONCENTRATIONS	WHICH ARE CONCENTRATED BY
Actinium	Ac	√	√	√						
Aluminum	Al				168	81,300	0.16-1.9	Bauxite, Al_2O_3	55-65% Al	–
Antimony	Sb				417	1	Present	Stibnite, Sb_2S_3	50-60% Sb	Liquation
Arsenic	As					5	0.003-0.024	Enargite, $3Cu_2S{\cdot}As_2S_5$		–
Barium	Ba		√		228	250	0.05	Barite, $BaSO_4$		Flotation
Beryllium	Be		√		112	6		Beryl, $3BeO{\cdot}Al_2O_3{\cdot}6SiO_2$	10-12% Be	Hand Cobbing
Bismuth	Bi		√		608	0.2	0.0002	Lead Ores	40-60% Bi	Flotation and Gravity
Boron	B		√		144	3	4.6	Borax, $Na_2B_4O_7{\cdot}10H_2O$		Evaporation
Cadmium	Cd		√		540	0.15	Present	Sphalerite, ZnS	1% Cd	Roasting and Sintering
Calcium	Ca		√		97	36,300	400	Limestone, $CaCO_3$		–
Cerium	Ce	√	√		431	46	0.0004	Monazite		Gravity
Cesium	Cs		√		117	7	0.002	Lepidolite	1% Cs	Hand Cobbing
Chromium	Cr				443	200	Present	Chromite $FeO{\cdot}Cr_2O_3$	35-50% Cr	Gravity Methods
Cobalt	Co		√		555	23	0.0001	Cobalt or Nickel Ores	0.8-10.0% Co	Flotation and Leaching
Columbium	Cb		√		524	24		Columbite, $Fe(Cb\text{-}TaO_3)_2$		Gravity
Copper	Cu				558	70	0.001-.09	Copper Ores	0.4-6.0% Cu	Flotation and Leaching
Dysprosium	Dy	√	√		534	4.5		Monazite		Gravity
Erbium	Er	√	√		572	2.5		Monazite		Gravity
Europium	Eu	√	√		319	1.1		Monazite		Gravity
Francium	Fr									
Gadolinium	Gd	√	√	√	495	6.4		Monazite		Gravity
Gallium	Ga		√		369	15	0.0005	Al Ores / Zn Ores		Caustic
Germanium	Ge		√		334	7	Present	Sphalerite, ZnS	0.01-0.015% Ge	Flotation
Gold	Au				1206	0.005	0.000006	Elemental Form	0.001% Au	Gravity, Flotation, Leaching
Hafnium	Hf		√		830	4.5		Zircon, $ZrO_2{\cdot}SiO_2$		Gravity Methods
Holmium	Ho	√	√		547	1.2		Monazite		Gravity
Indium	In		√		454	0.1		Zinc Ores		Flotation
Iridium	Ir		√		1399	0.001		CuNi Sulphide Ores		Flotation, Roasting, Extr.
Iron	Fe				490	50,000	0.002-0.02	Iron Ores	30-60% Fe	Gravity, Flotation
Lanthanium	La	√	√		384	18	0.0003	Monazite		Gravity
Lead	Pb				708	16	0.004-.005	Galena, PbS	6-10% Pb	Gravity or Flotation
Lithium	Li		√		33	65	0.1	Spodumene, $Li_2O{\cdot}Al_2O_3{\cdot}SiO_2$		Flotation
Lutetium	Lu	√	√		608	0.8		Monazite		Gravity
Magnesium	Mg				109	20,900	1272	Seawater		–
Manganese	Mn		√		449	1,000	0.001-.01	Manganese Ores	45-55% Mn	Flotation and Gravity
Mercury	Hg				846	0.5	0.0003	Cinnabar, HgS	1-3% Hg	Sorting and Screening
Molybdenum	Mo		√		636	15	0.0003-.002	Molybdenite, MoS_2	1-3% Mo	Flotation
Neodymium	Nd	√	√		434	24		Monazite		Gravity
Neptunium	Np			√				None (Man-made)		Treating Pile Products
Nickel	Ni				555	80	0.0001-.0005	Nickel Ores	1-3% Ni	Flotation and Leaching
Osmium	Os		√		1403	0.001		CuNi Sulphide Ores		Flotation, Roasting, Extr.
Palladium	Pd		√		759	0.01		CuNi Sulphide Ores		Flotation, Roasting, Extr.
Platinum	Pt		√			0.005	Present	CuNi Sulphide Ores	0.001% Pt	Flotation, Roasting, Extr.
Plutonium	Pu			√	1333			None (Man-made)		Treating Pile Products
Polonium	Po			√	587			Pitchblende		
Potassium	K				54	25,900	380	Sylvite, KCl		Flotation and Gravity
Praesodymium	Pr	√	√		414	5.5		Monazite		Gravity
Promethium	Pm	√	√					Monazite		Gravity
Protactinium	Pa			√						
Radium	Ra			√	312		2×10^{-10}	Pitchblende		Gravity, Flotation
Rhenium	Re		√		1281	0.001		Molybdenite, MoS_2		Flotation
Rhodium	Rh		√		780	0.001		CuNi Sulphide Ores		Flotation, Roasting, Extr.
Rubidium	Rb		√		95	310	0.2	Lepidolite		Hand Cobbed
Ruthenium	Ru		√		761	0.001		CuNi Sulphide Ores		Flotation, Roasting, Extr.
Samarium	Sm	√	√		487	6.5		Monazite		Gravity
Scandium	Sc		√		188	5	0.00004	Thortveitite, $(Sc, Y)_2Si_2O_7$		
Selenium	Se		√		299	0.09	0.004	Chalcopyrite, $CuFeS_2$		Flotation, Roasting
Silicon	Si		√		151	277,200	0.2-4.0	Silica, SiO_2		Flotation and Gravity
Silver	Ag				655	0.1	0.00015-.0003	Nonferrous Ores	0.07% Ag	Gravity or Flotation
Sodium	Na				61	28,300	10,561	Halite, NaCl		Flotation, Leaching
Strontium	Sr		√		158	300	13	Celestite, $SrSO_4$		–
Tantalum	Ta		√		1036	2.1		Tantalite, $Fe\ (Cb\text{-}TaO_3)_2$		Gravity
Technetium	Tc		√					None (Man-made)		
Tellurium	Te		√		389	0.002		Chalcopyrite, $CuFeS_2$		Flotation, Roasting
Terbium	Tb	√	√		520	0.9		Monazite		Gravity
Thallium	Tl		√		739	0.6	Present	Sphalerite, ZnS		Roasting and Sintering
Thorium	Th		√	√	705	12	0.0005	Monazite		Gravity
Thulium	Tm	√	√		583	0.2		Monazite		Gravity
Tin	Sn				359	40	0.003	Cassiterite, SnO_2	1.5-5.0% Sn	Gravity and Flotation
Titanium	Ti		√		281	4,400	Present	Rutile, TiO_2; Ilmenite	1-8% Ti	Gravity and Electrical
Tungsten	W		√		1204	69	Present	Tungsten Ores	60-70% W	Gravity and Flotation
Uranium	U		√	√	1166	4	0.00015-.0016	Uranium Ores		Flotation and Leaching
Vanadium	V		√		372	150	0.0003	Carnotite, $K_2O{\cdot}2UO_3{\cdot}V_2O$	3-8% V	Leaching
Ytterbium	Yb	√	√		447	2.7		Monazite		Gravity
Yttrium	Y	√	√		344	28	0.0003	Monazite		Gravity
Zinc	Zn				446	132	0.005-.014	Sphalerite, ZnS	10-30% Zn	Flotation and Gravity
Zirconium	Zr		√		399	220	Present	Zircon, $ZrO_2{\cdot}SiO_2$		Gravity Methods

[1] Parts per million.
Adapted from a chart prepared by Marshall F. Sittig, Exec. Sec'y, American Lithium Inst.

—How Metals Are Recovered

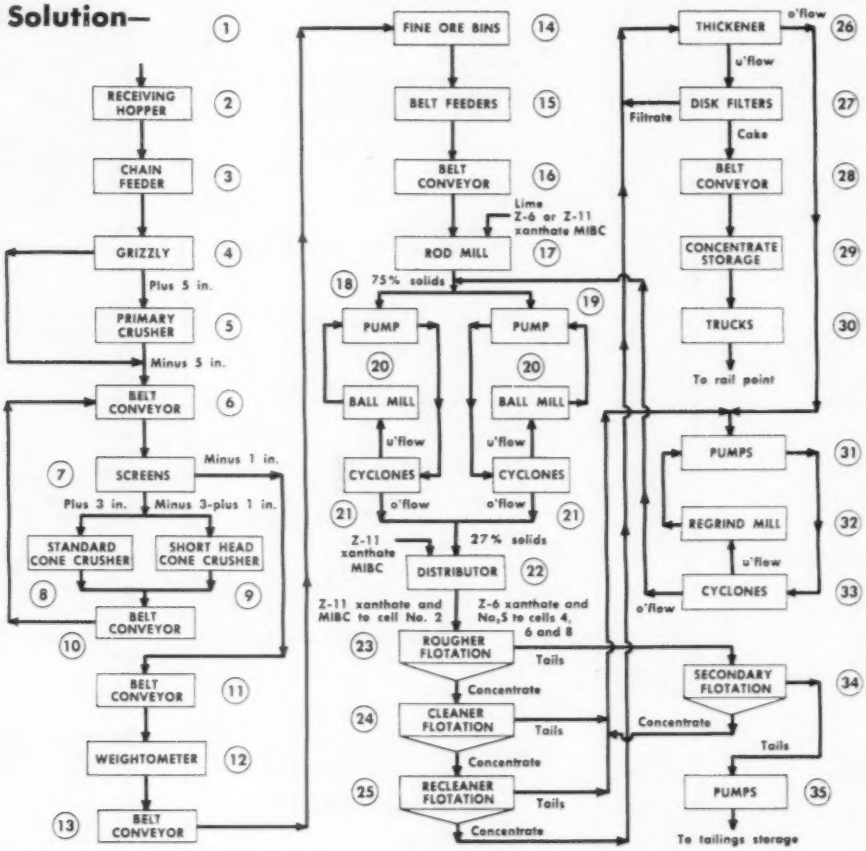
AND ARE CONVERTED BY	TO THESE MATERIALS	WHICH ARE CONVERTED TO	AND ARE PRODUCED AS FINISHED METALS BY
Caustic (Bayer Process)	Na Aluminate	Pure Alumina	Fused Salt Electrolysis
—	Pure Sb_2S_3	—	Iron Precipitation
Roasting	As_2O_3	—	Charcoal @ 1200-1300 °F
—	Pure $BaSO_4$	$BaCl_2$	Electrolysis
Acid Sinter plus Leaching	BeO	BeF_2	Magnesium @ 900-1300 °C
Smelting	Lead Bullion	Bismuth Bullion by Ca Treatment	Cl_2 @ 500°C to Remove Pb, Zn
	B_2O_3	Potassium Fluoborate	Electrolysis
Leaching	Cd-Zn Solution	Cd Sponge by Zn Dust Addn.	Distillation
Calcination	CaO	—	Aluminum in Vacuum
Sulphuric Acid Treatment	$Ce_2(SO_4)_3$	Tetravalent Ce Salts & ppted.	Electrolysis of Fused Chloride
Sulphuric Acid Treatment	Cs Alum	CsCl	Ca, Al, or Mg Reduction
Electric Furnace Treatment	Ferrochrome	—	Electrolysis
Acid Roasting or Smelting	$CoSO_4$ Soln	$Co(OH)_2$ by Milk of Lime	Electrolysis of Aq. Soln.
Caustic Fusion, then HCl, then KF	$CbKOF_2$	Columbium Oxide	Columbium Carbide in Vacuum
Smelting or Electrolysis	Cu Anodes	Copper Cathodes	Electrolysis
Sulphuric Acid Treatment	$Dy_2(SO_4)_3$	Pure Salts by Fract. Cryst/Ion-Exch.	Electrolysis of Fused Chloride
Sulphuric Acid Treatment	$Er_2(SO_4)_3$	" " " " "	" " "
Sulphuric Acid Treatment	$Eu_2(SO_4)_3$	" " " " "	" " "
Sulphuric Acid Treatment	$Gd_2(SO_4)_3$	Pure Salts by Fract. Cryst/Ion-Exch.	Electrolysis of Fused Chloride
CO_2 Treatment / Acid	$Ga_2O_3/GaCl_3$	—	Electrolysis
Roasting	Ge Oxide	Chloride then Hydrol. to Pure Oxide	Hydrogen
Cyanide or Smelting	AuCN or Au	Pure Gold	Zinc
Acid or Alkali	Hf-Zr Solns	Hf Solns by Ion-Exchange; to $HfCl_4$	Sodium
Sulphuric Acid Treatment	$Ho_2(SO_4)_3$	Pure Salts by Fract. Cryst/Ion-Exch.	Electrolysis of Fused Chloride
Acid Roasting	In = Sulphate	Water Solns	Displacement by Zinc Metal
Electrolytic Refining	Anode Slimes	$(NH_4)_2IrCl_6$	Hydrogen
Blast Furnace	Pig Iron	—	Coke in a Blast Furnace
Sulphuric Acid Treatment	$La_2(SO_4)_3$	Pure Salts by Fract. Cryst/Ion-Exch.	Electrolysis of Fused Chloride
Blast Furnace	Lead Bullion	Cu, Sn, As, Sb — Free Lead by S	Desilvering with Zn, Sb removal
Acid Roasting	Li_2SO_4	Li_2CO_3, then LiCl	Electrolysis of Fused Chloride
Sulphuric Acid Treatment	$Lu_2(SO_4)_3$	Pure Salts by Fract. Cryst/Ion-Exch.	Electrolysis of Fused Chloride
Lime Slurry	$Mg(OH)_2$	$MgCl_2$ with HCl	Electrolysis of Fused Chloride
Roasting in Reducing Atmos.	Mn^{++}	Pure Mn^{++} by Filtration	Electrolysis of Aq. Soln.
Roasting	Hg	—	Retorting Ore at 700°C
Roasting	MoO_3	Mo by Hydrogen Reduction	Power Metallurgy or Arc Melting
Sulphuric Acid Treatment	$Nd_2(SO_4)_3$	Pure Salts by Fract. Cryst/Ion-Exch.	Electrolysis of Fused Chloride
HF Treatment	NpF_6	—	Barium Reduction at 1300°C
Roasting and Leaching	(NiCuFe)S or Ni	Pure NiS by Molten Na_2S Extr. or Ni	C Reduction of NiO
Electrolytic Refining	Anode Slimes	$OsO_2(NH_3)_4Cl_2$	Hydrogen
Electrolytic Refining	Anode Slimes	$Pd(NH_3)_2Cl_2$	"
Electrolytic Refining	Anode Slimes	$(NH_4)_2PtCl_2$	"
—	—	—	Sodium Reduction
Sulphuric Acid Treatment	$Pr_2(SO_4)_3$	Pure Salts by Fract. Cryst/Ion-Exch.	Electrolysis of Fused Chloride
Sulphuric Acid Treatment	$Pm_2(SO_4)_3$	Pure Salts by Fract. Cryst/Ion-Exch.	Electrolysis of Fused Chloride
Acid Digestion	Ra Sulfate	Ra Bromide & Recrystallized	
Roasting	Re_2O_7	$KReO_4$	Hydrogen
Electrolytic Refining	Anode Slimes	$(NH_4)_3Rh(NO_2)_6$	Hydrogen
Acid Roasting	Rb Alum	RbCl	Ca, Al, or Mg Reduction
Electrolytic Refining	Anode Slimes	RuO_2	Hydrogen
Sulphuric Acid Treatment	$Sm_2(SO_4)_3$	Pure Salts by Fract. Cryst/Ion-Exch.	Electrolysis of Fused Chloride
Roasting with Carbon	Sc Carbide	Sc Oxide then Sc Fluoride	Electrolysis of Fused Chloride
Electrolytic Refining	Anode Muds	Sodium Selenate	SO_2 Pptn. from Aq. Soln.
Smelting	—	—	C Reduction in Electric Furnace
Blast Furnace	Lead Bullion	Ag-Zn Mixt. by Zn Treatment	Zn Distn, Electrolysis of Ag
—	—	—	Electrolysis of Fused Chloride
Digestion with Soda Ash	$SrCO_3$	SrCl	Electrolysis of Fused Chloride
Caustic Fusion, then HCl, then KF	K_2TaF_7	Ta by Sodium Reduction	Vacuum Sintering
Electrolytic Refining	Anode Muds	Sodium Telluride-Tellurate	SO_2 Pptn. from Aq. Soln.
Sulphuric Acid Treatment	$Tb_2(SO_4)_3$	Pure Salts by Fract. Cryst/Ion-Exch.	Electrolysis of Fused Chloride
Leaching of Flue Dust	Tl Chloride	TlS by H_2S, then to Sulphate	Electrolysis of Aq. Soln.
Sulphuric Acid Treatment	$Th(SO_4)_2$	Pure Salts by Fract. Cryst/Ion-Exch.	Reduction of ThO_2 by Calcium
Sulphuric Acid Treatment	$Tm_2(SO_4)_3$	Pure Salts by Fract. Cryst/Ion-Exch.	Electrolysis of Fused Chloride
Reverberatory Furnace	Impure Tin	—	Electrolytic Refining
Chlorination	$TiCl_4$	—	Sodium Reduction
Caustic Fusion	Na Tungstate	WO_3	Hydrogen
Acid or Alkali Leaching	U_3O_8	UF_4	Ca, Al, Mg or Na Reduction
Roasting with Salt	Na Vanadate	V_2O_5	Calcium Reduction
Sulphuric Acid Treatment	$Yb_2(SO_4)_3$	Pure Salts by Fract. Cryst/Ion-Exch.	Electrolysis of Fused Chloride
Sulphuric Acid Treatment	$Y_2(SO_4)_3$	Pure Salts by Fract. Cryst/Ion-Exch.	Electrolysis of Fused Chloride
Roasting	ZnO	—	Retorting with Coke at 1300°C
Acid or Alkali	Hf-Zr Solns	HF Removal by Ion-Ex., conv. to $ZrCl_4$	Sodium Reduction

Problem—To concentrate Pima Mining Co.'s Pima County, Ariz. orebody at 3,000 tpd. Ore occurs along the Mineral Hill fault, usually at intersections with cross faults, or at or near intrusive contacts with limestone or quartzite. Deposits are of the contact metamorphic type with mineralization occurring sporadically along shear zones in the limestone, and disseminated through the contact silicates.

Two distinct types of mineralization occur — high-grade, strongly mineralized in limestone which is highly altered, and low-grade disseminated in what was originally a dolomite and is now a calcium silicate rock called hornfels. Some oxidation extends a short distance into bedrock with chrysocolla and tenorite present in minor amounts.

Chalcopyrite is principal mineral with smaller amounts of bornite and chalcocite. Some magnetite, pyrite, sphalerite, molybdenite and scheelite occur. Gangue is limestone, quartz, hematite, pyrite, calcite and silicates. Mill heads assay 1.78% Cu (1.66% sulphide and 0.12% oxide).

Solution—



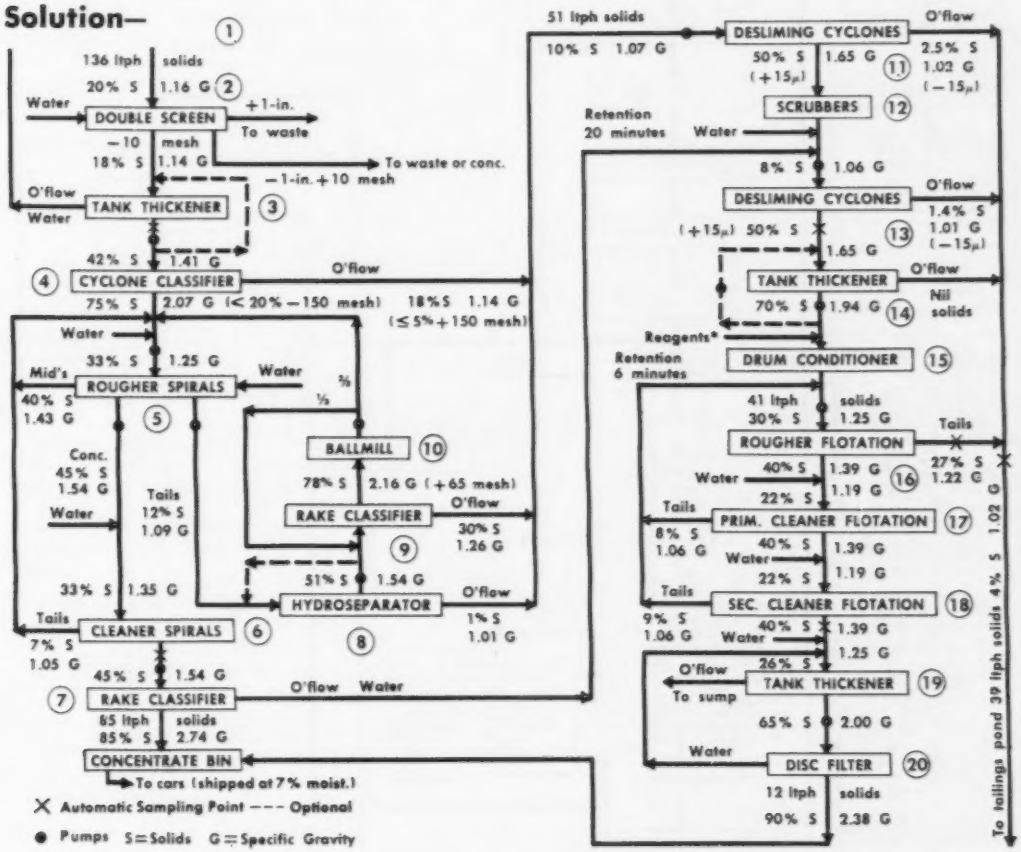
LEGEND

1. Kenworth 802-B 34-yd tractor-trucks
2. Receiving hopper
3. Ross chain feeder
4. Bar grizzly, 4- to 7-in. openings
5. Birdsboro-Buchanan 66x84-in. H-Type C-DF jaw crusher
6. 54-in. belt conveyor, 350-ft centers
7. Two W. S. Tyler double-deck F-900 Tyrock screens. Top deck, 3x18 in. Bottom deck 1x1 in.
8. 7-ft standard Nordberg cone crusher
9. 7-ft Nordberg short-head cone
10. 36-in. belt conveyor, 220-ft centers
11. 36-in. belt conveyor, 180-ft centers
12. Merrick Model E Weightometer, 600 tph capacity
13. 36-in. belt conveyor and L-B tripper, 125-ft centers
14. Two 50-ft dia steel fine-ore bins. Capacity 2,000 to 2,500 live tons each
15. Four 30-in. belt feeders, 45-ft centers, controlled automatically
16. 30-in. belt conveyor, 70-ft centers
17. Allis-Chalmers 10x13-ft rod mill
18. Two Hazeltown 10-in. pumps. Variable speed drive. Type CT
19. Two American Manganese 10-in. steel pumps. Variable speed. Type T
20. Two Allis-Chalmers 10½x13-ft ball mills
21. Set of three Model D-20-B Krebs 20-in. cyclones (6 total)
22. Distributor
23. Twelve 66-in. Fagergren flotation cells arranged in 3 rows of 4 cells each
24. Five 66-in. Fagergren cells in one row
25. Four 66-in. Fagergren cells in one row
26. 50-ft Dorr-Oliver thickener
27. Two Eimco Agidisc filters. Seven disks, 6 ft dia.
28. 18-in. belt conveyor, 140-ft centers
29. Concentrate storage
30. Trucks to rail point
31. Canadian Allis-Chalmers Type SRL 10-in. sand pumps
32. Allis-Chalmers 7x12-ft ball mill
33. Six Model D-10-B 10-in. Krebs cyclones
34. Eighteen 66-in. Fagergren flotation cells arranged in 3 rows of 6 cells each
35. Canadian Allis-Chalmers Type SRL 10-in. tailings pumps

Results—Total recovery is 87.82% Cu. Tails average 0.25% Cu. Concentrates assay 25.56% Cu and 3.27 oz Ag. Molybdenite is not now recovered, but may be in the future.—Source *E&MJ*, March 1958.

Problem—To recover and concentrate iron from old washer tails at Jones & Laughlin Steel Corp.'s Hill Annex reclamation plant, Calumet, Minn. Some 6-million tons are to be dredged from the pond and fed to the mill at 136 tph. Hematite occurs as coarse grains; silica as fine sand. Mill treats 90% of feed by spirals and the rest by flotation. Ratios may be reversed in the future. Tails assay about 42% Fe.

Solution—



LEGEND

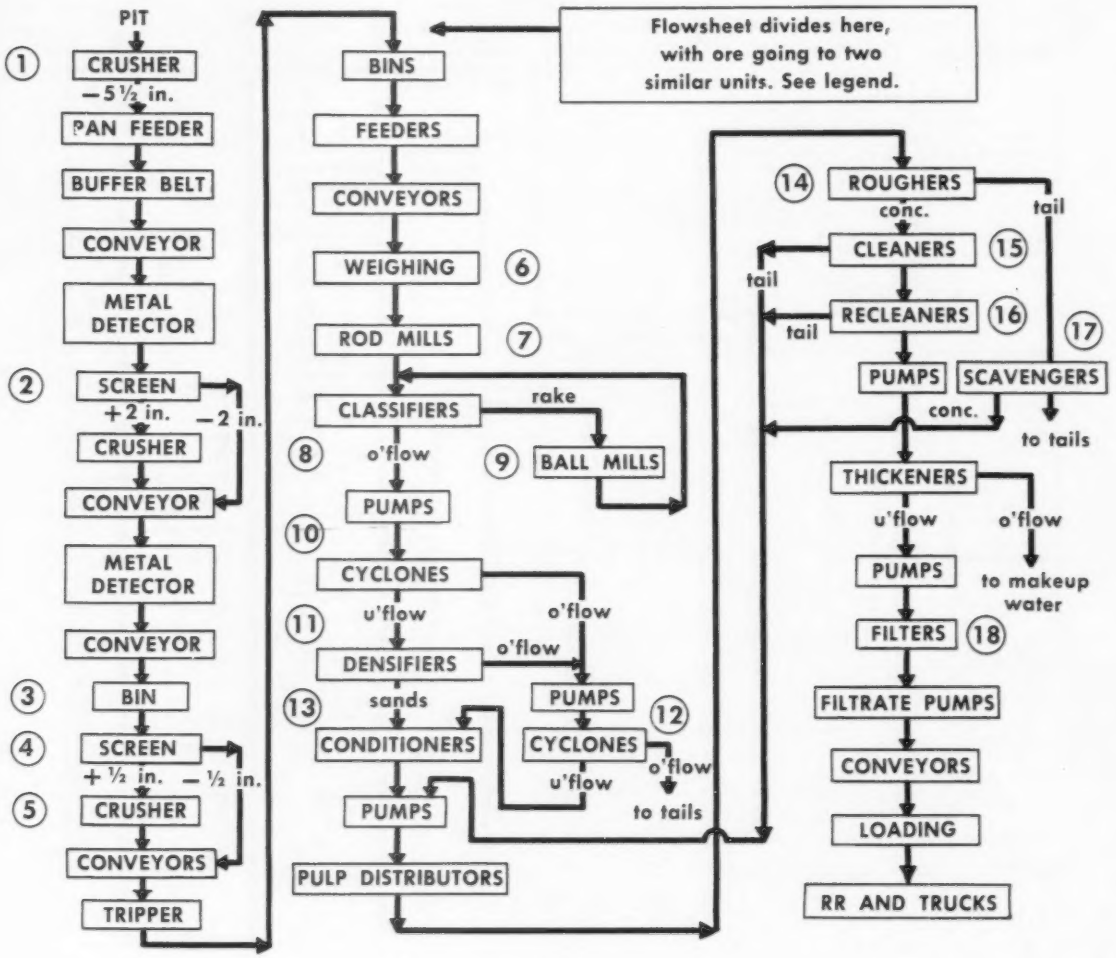
*Reagents: Petroleum sulfonate, 3.0 lb per lt, fed by piston pump; fuel oil, 3.4 lb per lt, fed as above; H_2SO_4, 3.0 lb per lt, fed by Pulsafeeder.

1. Electric suction dredge: 30-in. revolving cutter head, 10-in—eventually 14-in. discharge centrifugal pump, 350hp
2. Double deck screen: one 6x14 (outside building)
3. Thickener: one 70-ft dia (outside building)
   Pumps: one 8x6 CWG & one 10x8 CKG
4. Cyclone classifier: one 24-in. Sump pump; one 10x8 CWG
5. Rougher spirals: 128 5-turn. Pump: two 8x6 CWG
6. Cleaner spirals: 75 5-turn. Pump: one 8x6 CWG
7. Dewatering rake classifier: one 6x26—mounted over RR loading bin
8. Hydroseparator: one 24-ft. Pump: one 6-in. triflex diaphragm
9. Rake classifier: one 4x34
10. Ball mill: one 8x9. Pump: one 2-in. Cyclone feed pump: one 10x8 CWG
11. Desliming cyclones: nine 10-in. cylindrical and 4-in. conical combination, rubber-lined
12. Scrubbers: 2 banks of four 66x66-in. with swirl baffles to prevent vortexing, modified Fagergren rotor without stator, 20hp each cell. Pump: one 8x6 CWG
13. Desliming cyclones: 8 as at 12
14. Thickener: 30-ft dia. Pump: 6-in. duplex diaphragm. Optional bypass pump: 2-in.
15. Drum conditioner: one 6x16 black iron. Pump: one 5x5 NRL rubberlined
16. Rougher flotation: 2 banks of three 43x 43-in. Type M stainless steel
17. Primary cleaner flotation: two 43x43 in. Denver Equipment Co. Sub A
18. Secondary cleaner flotation: two 43-43-in. Denver Equipment Co. Sub A
19. Thickener: 30-ft dia. Pump: one 5x4 CWH
20. Filter: 7 disc (using only 2 now) with wet type vacuum pump (over bin)

Results—Output is 100 tph of 60% Fe concentrate. Flotation is critical, requiring six minutes conditioning time at high density with above reagents.—Source *E&MJ* January 1958.

Problem—To concentrate a 35% Fe jasper ore on the northern Michigan Marquette Range. Marquette Iron Mining Co., Republic, Mich. decided to use flotation at 3,500 tpd. Finished flotation concentrate is about 70% minus 200 mesh. Total cost of the project is estimated to be $18- to 20-million for the concentrator.

Solution—



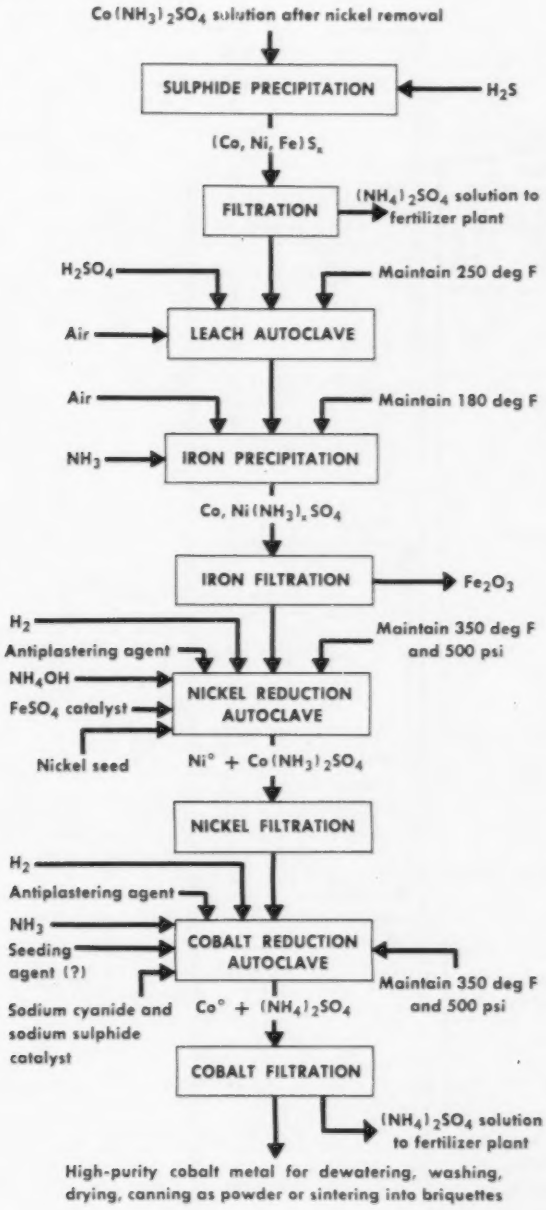
LEGEND

1. 48-in. Traylor gyratory crusher
2. 6x12-ft Simplicity screen
3. Surge bin, 150 long ton capacity
4. 6x14-ft Simplicity screen
5. 7-ft Symons short head cone crusher
6. In Unit No. 1, ore travels over a Conveyoflo scale, in Unit No. 2, over a Transportometer scale
7. One 9x12-ft Hardinge rod mill in each unit
8. One 14-in. Dorr Hydroscillator in each unit
9. One Hardinge ball mill in each unit. Convex feed head is 11 ft dia by 3 ft long and Tricone cylinder is 11 ft dia at one end and 10 ft dia at other end, by 6 ft long
10. One 24-in. DorrClone each
11. One 54-in. Duplex densifier each
12. Twenty-four 6-in. DorrClones in each unit
13. Four conditioners in each unit
14. Two lines of 4 Fagergren No. 66 cells in Unit No. 1; three lines of 5 Denver No. 24 cells in Unit No. 2
15. Two lines of 2 Fagergren No. 66 cells in Unit No. 1; three lines of 3 Denver No. 24's in No. 2
16. Two lines of 2 Fagergren No. 66's in No. 1; three lines on 3 Denver 24's in No. 2
17. Two lines of 2 Fagergren No. 66's in No. 1; three lines of 2 Denver No. 30's in No. 2
18. Three 8x10-ft filters (one unit is on standby)

Results—Some 500,000 annual tons of 60% Fe concentrate are produced, pelletized and shipped. McDowell Flying Saucers are used to pelletize the concentrate.—Source *E&MJ*, January 1957.

Problem—To recover pure cobalt from the nickel refinery residual solutions after separating the nickel. Sherritt Gordon Mines Ltd., Ft. Saskatchewan, Alberta, precipitated cobalt as the sulphide, then sent the precipitate to the pilot plant where cobalt is refined on a semi basis. Cobalt process is similar to nickel process, except that the copper strip is omitted. Nickel refinery flowsheet is discussed on next page.

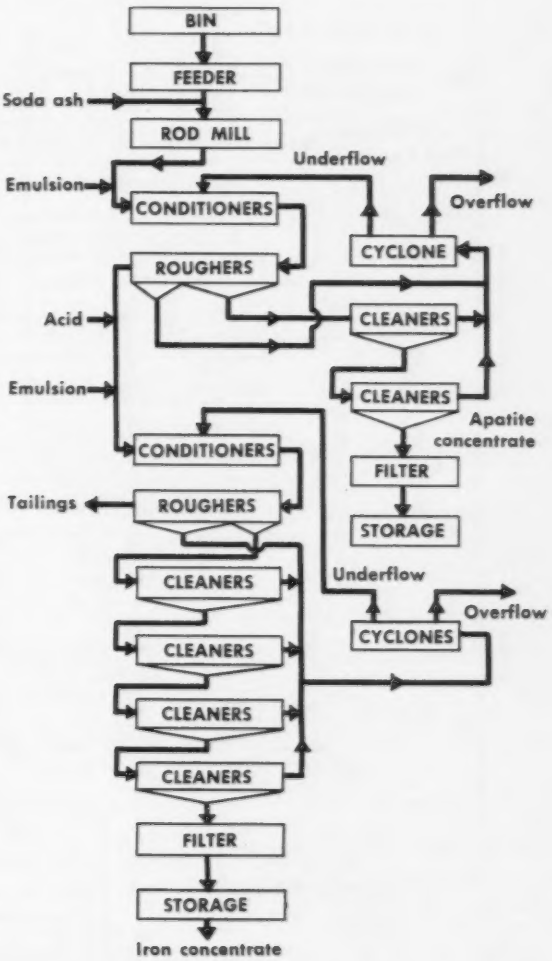
Solution—



Results—Selective stripping of residual iron and nickel, then hydrogen reduction of the pure solution yields pure cobalt powder.—Source, Machiw and others, 1958 AIME annual meeting.

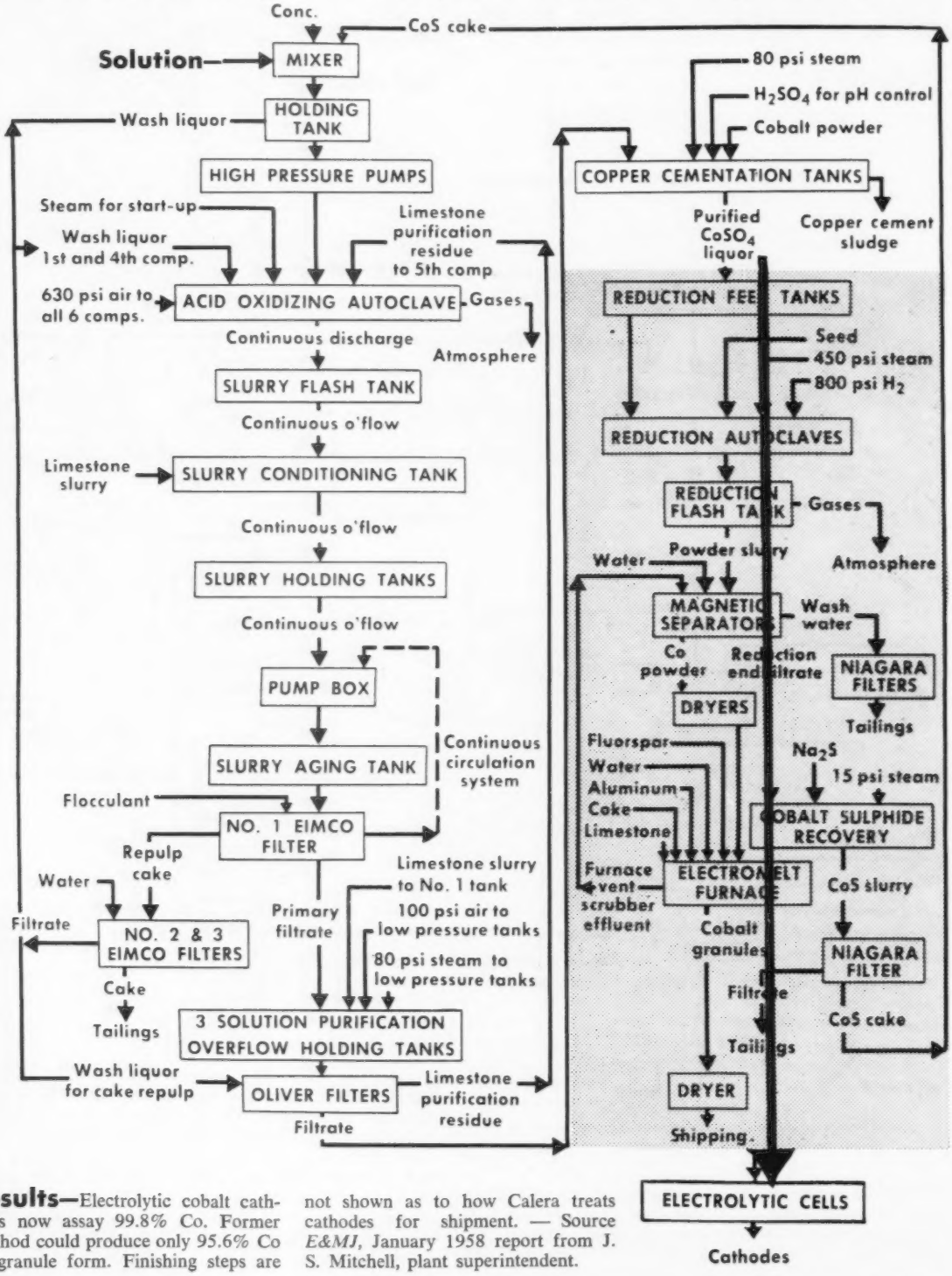
Problem—To develop a flotation method for Swedish hematite ore. Royal Institute of Technology, Stockholm, Sweden, suggested the following method on ore ground to minus 4mm. The pH in roughers is 6 and in cleaners 4. Apatite circuit pH is 8.7.

Solution—



Results—Excellent in pilot runs. Reagents were emulsified tall oil and fuel oil. According to P. G. Kihlstedt, Royal Institute, ore was crushed and ground to minus 4mm at 150 kg/hour with 1-in. rods. Fine grinding then took the feed down to 0.3mm. Hematite circuit reagent rates were 600 g/ton tall oil and 1200 g/ton fuel oil—Source International Mineral Dressing Congress, Stockholm, 1957 (See Special Report on the meeting in *E&MJ*, November 1957).

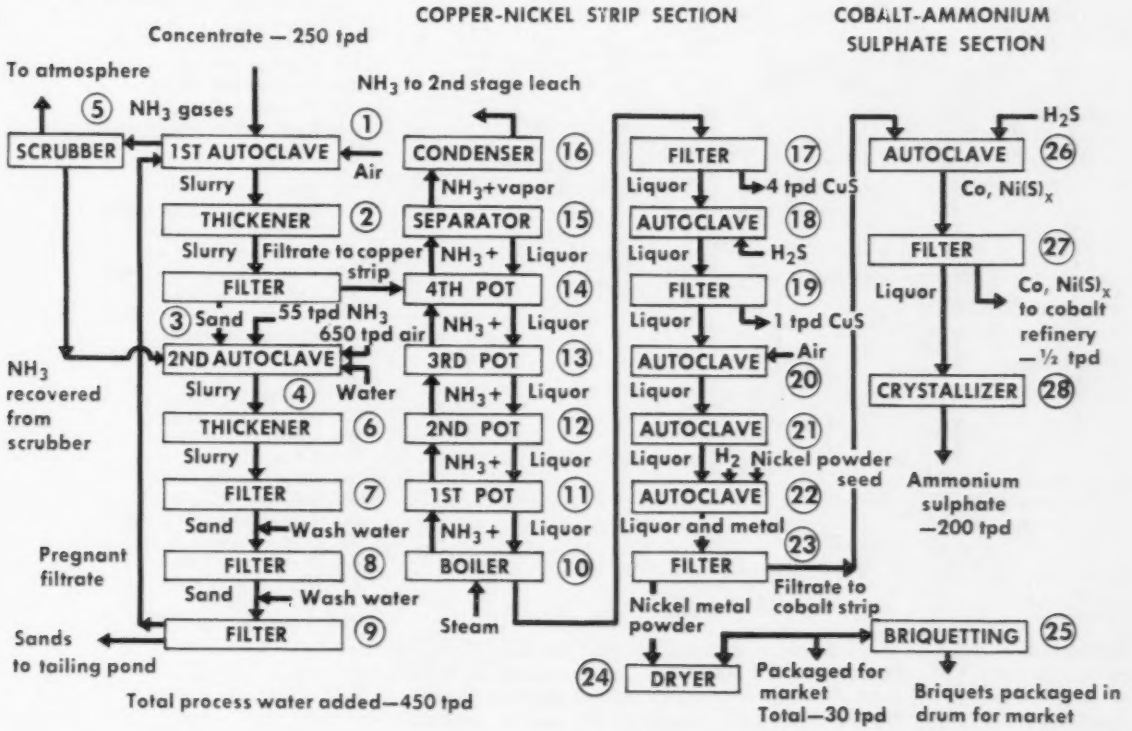
Problem—To improve an existing cobalt refining process which gave only a 95.6% cobalt product. Howe Sound's Calera Mining Co., Garfield, Utah, developed an electrolytic process, based on the Rhodesian Process, which eliminated all the steps between a purified cobalt-bearing solution and the finished product. See flowsheet below. Cathodes used as starter sheets are stainless steel, while the anodes are lead. Electrolyte is dilute cobalt sulphate which is circulated through 28-cell tank house. Total tank house voltage is only 150 v. Cathodes are stripped every seven days. Feed to the refinery is a concentrate of cobalt-copper-nickel sulphides and arsenides.



Results—Electrolytic cobalt cathodes now assay 99.8% Co. Former method could produce only 95.6% Co in granule form. Finishing steps are not shown as to how Calera treats cathodes for shipment. — Source *E&MJ*, January 1958 report from J. S. Mitchell, plant superintendent.

Problem—To refine nickel and cobalt from a sulphide concentrate prepared at Lynn Lake, Manitoba. Sherritt Gordon Mines Ltd. established an ammonia leach to form soluble nickel, cobalt and copper sulphates which were selectively recovered. Copper is precipitated as sulphide. Nickel is reduced to metal by hydrogen reduction. Cobalt is recovered by same process (see separate flowsheet). Process yields 30 tpd pure nickel.

Solution—



LEGEND

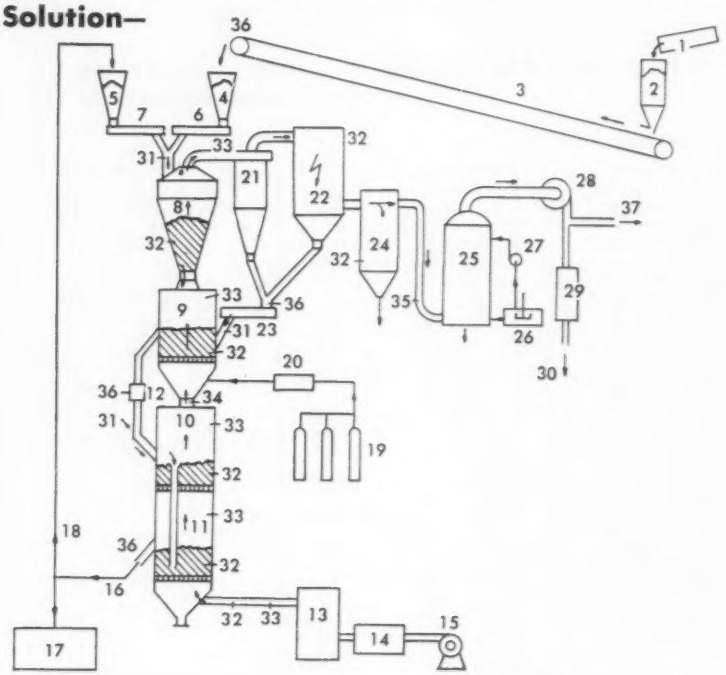
1. Primary leach autoclaves (2), 11-ft dia by 45 ft long, 20% stainless ELC clad. Water jacketed with coolers in shell, partitions, heads, plus internal coils. Agitators—4 each (50 hp)
2. Adjustment thickener. Concrete dome and shell, with one course brick-set-lining over ¼-in. Pyroflex membrane. Autorise. 105-ft dia
3. Adjustment filters, 7 disks, 8-ft 6-in. dia with 650 sq ft cloth. Nylon or Polythene. All wetted surfaces are 304 stainless
4. Secondary leach autoclaves (6), same size and construction as No. 1 above with water coolers in jacket, shell and partitions. 30-hp drive on agitators
5. Conventional gas scrubbing tower to reclaim NH_3 and return gas to process
6. Final thickener is same construction as No. 2 above
7. and 8. Wash filters are disk, 8-ft 6-in. dia with 925 sq ft Nylon or Polythene cloth. All wetted surfaces are 304 stainless
9. Final filter is same as No. 7 and 8 above
10. thru 16. Copper reboil equipment: Pots 11, 12, 13 and 14 are 9-ft dia by 9 ft 6 in. in 316 ELC stainless. Reboiler (No. 10) is 11-ft dia by 30 ft in 316 ELC. Condenser for ammonia vapor is 36-in. dia by 17 ft of carbon steel
17. Sweetland filter press to remove copper sulphide, runs at 50 psi, is 36-in. dia and lined with 316 ELC
18. Stripping autoclave is 5-ft dia by 26 ft and in 316 ELC
19. Final copper filter is Sweetland, same as No. 17 above
20. Oxidation autoclave operates at 350 deg F and 690 psi. Construction is 5 ft 6 in. dia by 22 ft of 1 34/32-in. type 10% clad 316. Four turbine agitators of 10 hp each
21. Hydrolysis autoclave operates at 465 deg F and 610 psi, is same as above, but with four radial-tip agitators, 10 hp each
22. Reduction autoclave feed tank runs at 400 deg F and 200 to 250 psi. Construction is 8-ft dia by 30 ft long of ¾-in. 20% clad 316. No agitators

    Reduction autoclave runs at 350 to 400 deg F and 350 to 500 psi. It is 6-ft dia by 25 ft long of 1 1/3-in. clad 316. Four 25 hp, radial-tip agitators
23. Wemco screw classifier and horizontal rotary filter, both stainless
24. Direct-fired rotary dryer is 3x30 ft long
25. Sintering furnace is gas-fired, radiant-tube, mesh belt; sinters at about 1,600 deg F briquettes from Kamarek Greaves briquetting rolls
26. Cobalt precipitation autoclave runs at 155 deg F and 5 psi. It is 5-ft 9-in. dia by 18 ft and made from ⅜-in. 316 ELC. Three 15-hp radial-tip agitators
27. Sweetland filter runs at 150 deg F and 50 psi max., same dimensions as Sweetland Filter used in No. 17
28. Crystalizers are triple effect evaporator, that discharge to automatic batch centrifuges with crystals going to direct-fired rotary dryer, then to storage for bagging and shipment

Results—High-purity nickel powder and briquettes are produced at better than 90% nickel recovery. Copper sulphide is shipped to Noranda. Cobalt is recovered in a pilot plant.—Source *E&MJ*, Mid-June 1957.

Problem— To recover base metals from arsenical-nickel sulphide flotation concentrate produced at Muhlbach am Hochkonig. Mitterberg Mining Co. turned to dry chlorination as the solution.

Solution—



LEGEND

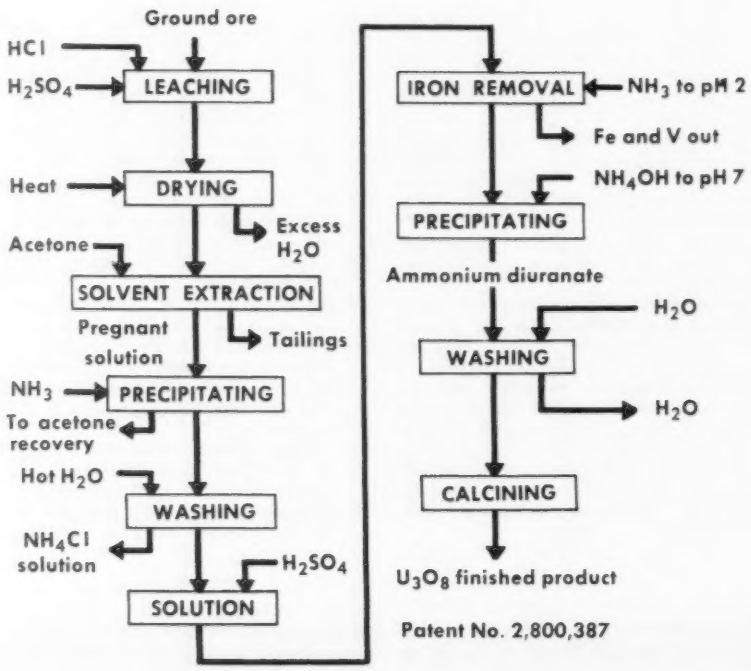
1. Rotary drier
2. Bunker for dried pyrite
3. Conveyor
4. Charging dried pyrite
5. Charging of return
6. Screw conveyor, heated
7. Screw conveyor, heated
8. Venturi reactor
9. Fluidized bed reactor
10. Fluidized bed reactor
11. Fluidized bed reactor
12. Lurgi system shut-off device
13. Air heater
14. Air drier
15. Blower
16. Discharging roasted residue
17. Leaching
18. Return line
19. Steel cylinders for chlorine
20. Chlorine evaporater
21. Cyclone to separate dust
22. Electric gas cleaner
23. Dust return
24. Sulphur condenser
25. Scrubber for $AsCl_3$
26, 27. Agitator, pumps
28. Blower
29. Return gas drier
30. To return gas line
31. Scavenger nitrogen
32. Temperature control points
33. Pressure control points
34. Oxygen control device
35. SO_2 control device
36. Solids sampling
37. Waste gas discharge

Results— Adding air to the reactor re-oxidizes any iron chlorides back to oxides, reducing the total chlorine consumption.—Source, Second International Mineral Dressing Congress, Stockholm as abstracted in *E&MJ*, November 1957. A paper by H. Hohn, G. Jangg, L. Putz and E. Schmiede.

Problem— To recover uranium from shales by acid solution and solvent extraction with acetone. Patent was assigned to AEC by R. B. Kimball and R. A. Ewing—No. 2,800,387.

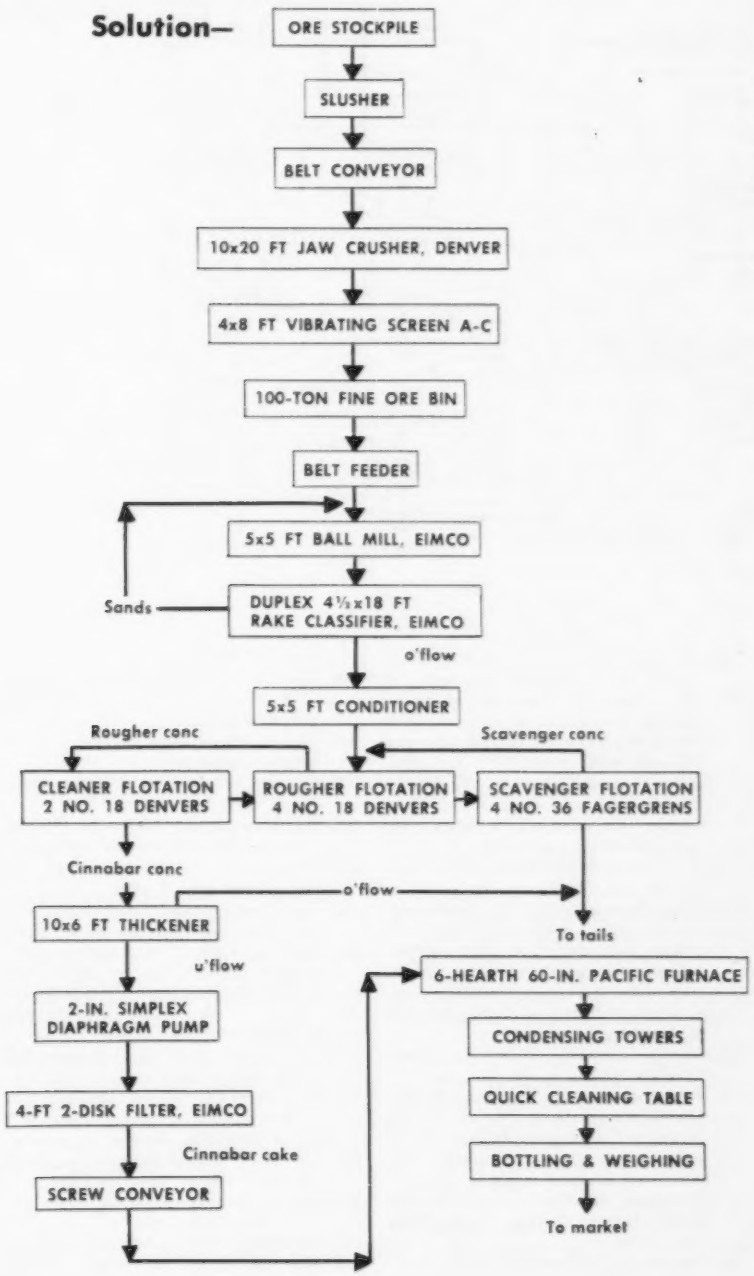
Solution—

Results— Uranium is extracted with acetone, stripped, purified and reprecipitated as diuranate.—Source *E&MJ*, November 1957.



Problem—Recovery of mercury from a low-grade orebody which runs 20 to 25% moisture and does not respond well to roasting—fuel costs would be too high. Flowsheet below was developed by Keith Kunze, general superintendent, Getchell Mine for Sam Arentz of Arentz-Comstock. Mine is the old Bretz property in Malheur County, Ore. Cinnabar responds well to the flotation process shown here. Mill capacity is 150 tpd.

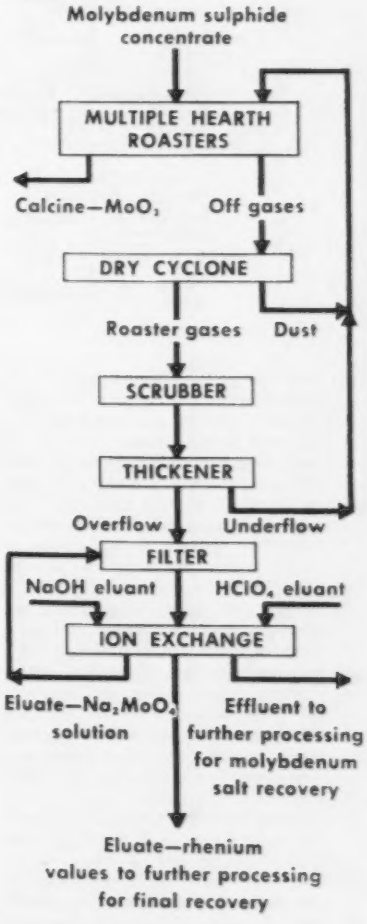
Solution—



Results—Flotation concentrate runs 50 to 60% mercury by dry weight and is distilled to metal in a Pacific Roaster. Recovery is very high on ore running only 2.5 lb mercury per ton.—Source *E&MJ*, March 1958.

Problem—To extract rhenium from molybdenite flotation concentrate produced at Kennecott Copper Corp. property. Following flowsheet and patent were suggested by S. R. Zimmerley and E. E. Malouf in patent No. 2,809,092.

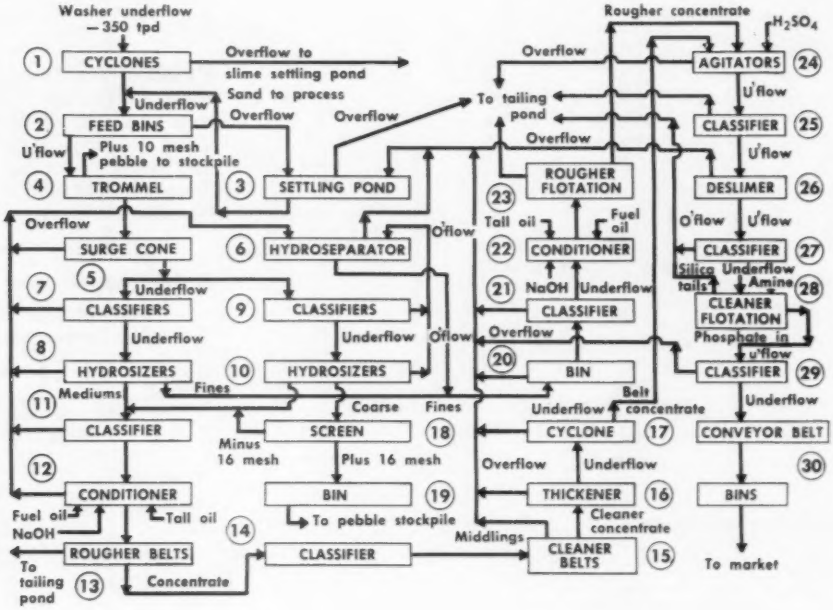
Solution—



Results—A high grade rhenium eluate from the ion exchange columns which can be sent to further processing for rhenium recovery. High recovery, low-cost and high-purity product were offered as advantages for this patent.—Source *E&MJ*, January 1958.

Problem—To recover and concentrate Florida pebble phosphate at Smith-Douglass Co., Inc.'s Coronet Phosphate Co. mine at Tenoroc, Fla. Ore is mined by dragline and pumped to mill at 400 to 450 cubic yards per hour. Matrix runs 3 to 4% pebble and 40% clay. Combination of Dorr-Clones to deslime, belt concentrators on coarse, and flotation on fines was installed. Belt concentrators rough and finish, replace shaking tables.

Solution—



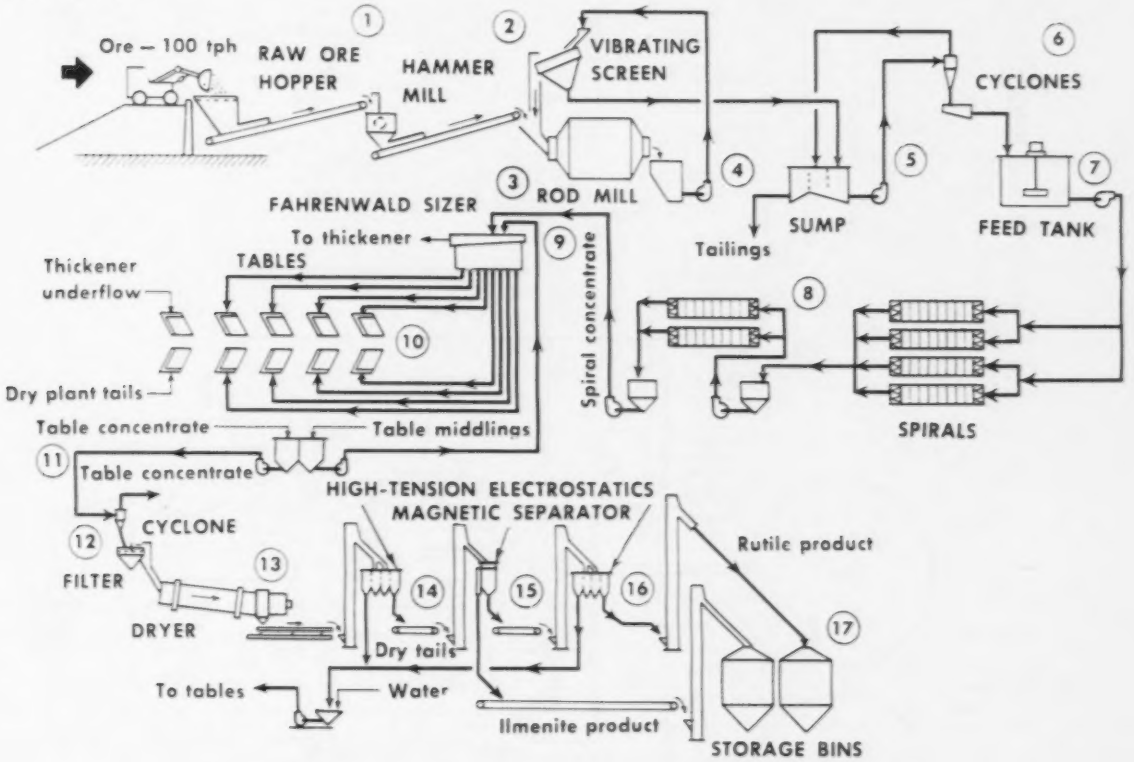
LEGEND

1. Seven 24-in. DorrClones fitted with individual submerged discharge boxes that eliminate need for apex valves on these desliming units. Cyclones deslime at 150 mesh, with overflow going direct to slime disposal. Underflow is about 60% solids on 12 to 17 psi feed pressure
2. Two 40-ft feed bins located directly under the cyclones. Overflow goes to settling pond, and underflow goes to plant circuit
3. Settling pond collects all overflows and phosphate-containing washes through a catch-all pump, and returns both overflow and underflow to the plant circuit
4. Trommel screen washes and separates plus 10-mesh pebble for the stockpile
5. Surge cone contnues the desliming step, sending overflow to a 40-ft Hydroseparator. Underflow is split to a 12-ft Dorr rake and a 6-ft rake
6. Hydroseparator, 40-ft dia, collects overflow from No. 5, 7, 8, 9 and 10, and sends it to the settling pond
7. Dorr rake classifier, 12-ft wide. Overflow goes to No. 6. Underflow goes to No. 9
8. Four 8-pocket Fahrenwald hindered settling sizers, made by General American Transportation Corp. Overflow goes to No. 6 and underflow is split into two products. Plus 65-mesh goes to No. 11. Minus 65-mesh goes to No. 20
9. Dorr rake classifier, 6 ft wide. Overflow goes to No. 6. Underflow goes to No. 10
10. Two 8-pocket Fahrenwald sizers by General American Transportation Corp. Overflow goes to No. 6. Underflow plus 65-mesh goes to No. 11. Underflow minus 65-mesh goes to No. 20. Underflow plus 16-mesh goes to No. 18
11. Simplex screw classifier, 66-in. dia, whose overflow goes to No. 6
12. Drum conditioner. Caustic, tall oil and fuel oil are added
13. Three 42-in. wide by 70-ft centers, continuous rubber belts fitted with bars, baffles and water jets that separate agglomerated pebble. Tailings off the ends of the belts go to the tailing pond. Concentrate from sides of the belts goes to No. 14
14. Simplex classifier, 54-in. dia screw. Overflow returns to No. 3
15. Two 60-in. wide by 70-ft centers, continuous cleaner belts fitted with bars, baffles and water jets. Tailings off the ends of the belts are considered middlings and returned to No. 3. Concentrate from the sides of the belts joins rougher flotation concentrate after steps No. 16 and 17
16. Concentrate thickener, 30-ft dia. Overflow goes to No. 3
17. Cyclone, 24-in. dia, whose overflow returns to No. 16
18. Two Allis-Chalmers vibrating screens with 16-mesh cloth. Oversize moves to pebble stockpile
19. Bin to deliver plus 16-mesh rock to pebble stacker belt
20. Flotation cell feed bin. Overflow enters No. 3. Underflow to No. 21
21. Dorr rake classifier, 16 ft wide. Overflow returns to No. 3. Underflow feeds No. 22
22. Three 2-cell conditioners. Caustic, tall oil and fuel oil are added
23. Four 4-cell banks of Mineral Separations' flotation machines. Underflow is tailings
24. De-oiling agitators take agglomeration-flotation concentrates and de-oil with H_2SO_4. Overflow passes to tailing pond
25. Two 54-in. dia Simplex classifiers split discharge from the de-oiler
26. V-box deslimer further deslimes and cleans concentrate
27. Two 54-in. dia Simplex classifiers split underflow from No. 26. Overflow is a tailing. Underflow feeds to flotation
28. Two 6-cell banks of Mineral Separations' machines. Amines float the silica
29. Duplex classifier, 54-in. dia screw, dewaters for stacker belt
30. Concentrate stacker belt delivers from four 200-ton bins to stockpile or bins deliver directly to the railroad for delivery to market or to Coronet, Fla.

Results—High-grade pebble rock, and a mixed agglomeration belt product and flotation concentrate are produced. DorrClones successfully deslime, producing a 60% solids underflow.—Source *E&MJ*, December 1957.

Problem—To recover rutile and ilmenite from soil and saprolite above orebearing pegmatites in a host rock or quartz monzonite gneiss in typical Piedmont rocks in Hanover County, Va. Metal & Thermit Corp., New York, N. Y. installed a 100-tph mill to treat ore mined by bowl scrapers. Ore runs 2.5% heavy minerals (50-50 rutile and ilmenite) and is crushed, ground, and deslimed in cyclones ahead of the rougher spirals. Tables reclean spiral concentrate which is dried, then separated by magnets and high-tension electrostatics.

Solution—



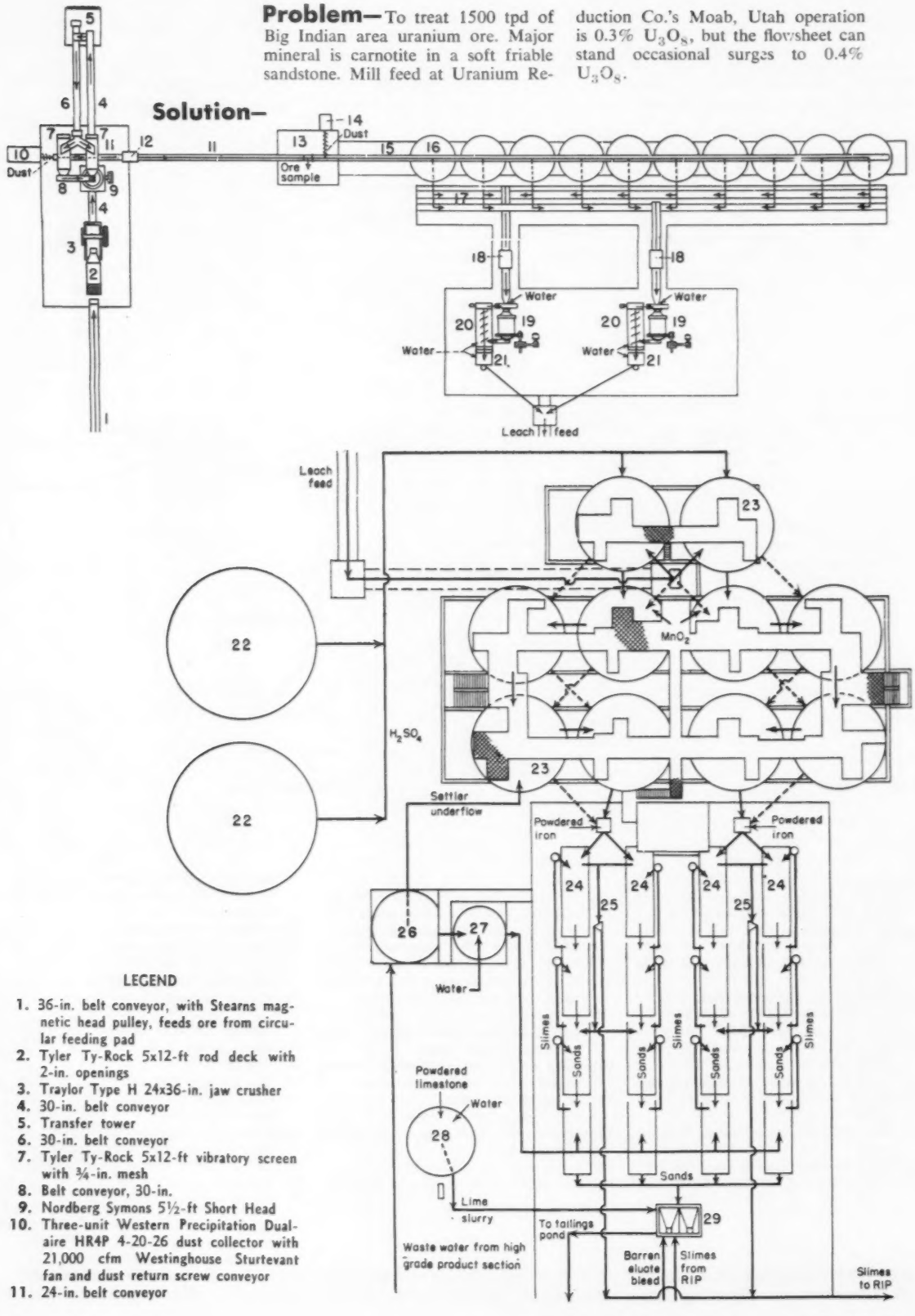
LEGEND

1. Caterpillar Tractor Co. front-end loader delivers to hopper outside wet mill. Ore feeds by conveyor to hammer mill
2. Ore is crushed to minus 1 in. in a Pennsylvania Crusher Div., Bath Iron Works hammer mill, then travels by belt to the rod mill
3. Hardinge Co. rod mill reduces pulp to minus 30-mesh in closed circuit with #4
4. Allen-Sherman-Hoff Pump Co. pump feeds Deister Concentrator Co. Leahy screen with 30 mesh cloth
5. Slurry feeds to sump, then up to cyclones through a Morris Bros. Machinery Co. pump
6. 14-in. dia wet cyclones deslime ahead of spirals
7. Spiral feed tank with General American Transportation Corp. Turbo-Mixer Div. agitator
8. Humphreys Investment Co. spirals divided into roughers and cleaners. Total of 60 five-turn units are fed by Allen-Sherman-Hoff Pump Co. pumps
9. 8-cell Fahrenwald-type sizer splits heavies to two banks of sand and slime tables. Overflow goes to thickener
10. Deister Concentrator Co. tables. Sand tables have rubber deck and riffles. Slime tables use wooden riffles
11. Table concentrate goes through a Denver Equipment Co. pump to a cyclone
12. Carpco Manufacturing, Inc. filter dewaters ahead of the dryer
13. Oil-fired 4 x 25 ft Edw. Renneburg & Sons Co., dryer
14. Shaker conveyor and belt elevator takes dry feed to four Carpco high-tension statics. Tails return to tables. Conductors go to the Stearns Magnetic separator
15. Magnetic separator cuts out the ilmenite product and sends rutile-bearing nonmagnetic to the rutile static cleaner. Magnet is Stearns Magnetic, Inc.
16. Carpco high-tension statics make final rutile concentrate and return dry tails through a Denver Equipment Co. pump to a table. Bucket elevators are by Carpco
17. Storage bins deliver to truck for shipment to railroad at Ashland, Va. Tailing line sump pump is Morris Machine Works. River and pond water pumps are Worthington. Service water pump is a Gould. Surface run-off pump is a Marlowe

Results—Rutile concentrate assays 94% TiO_2 and that of the ilmenite 52 to 53% TiO_2. Metal & Thermit is scheduled to produce 5,000 annual tons of rutile and an equal amount of ilmenite.—*E&MJ*, January 1958.

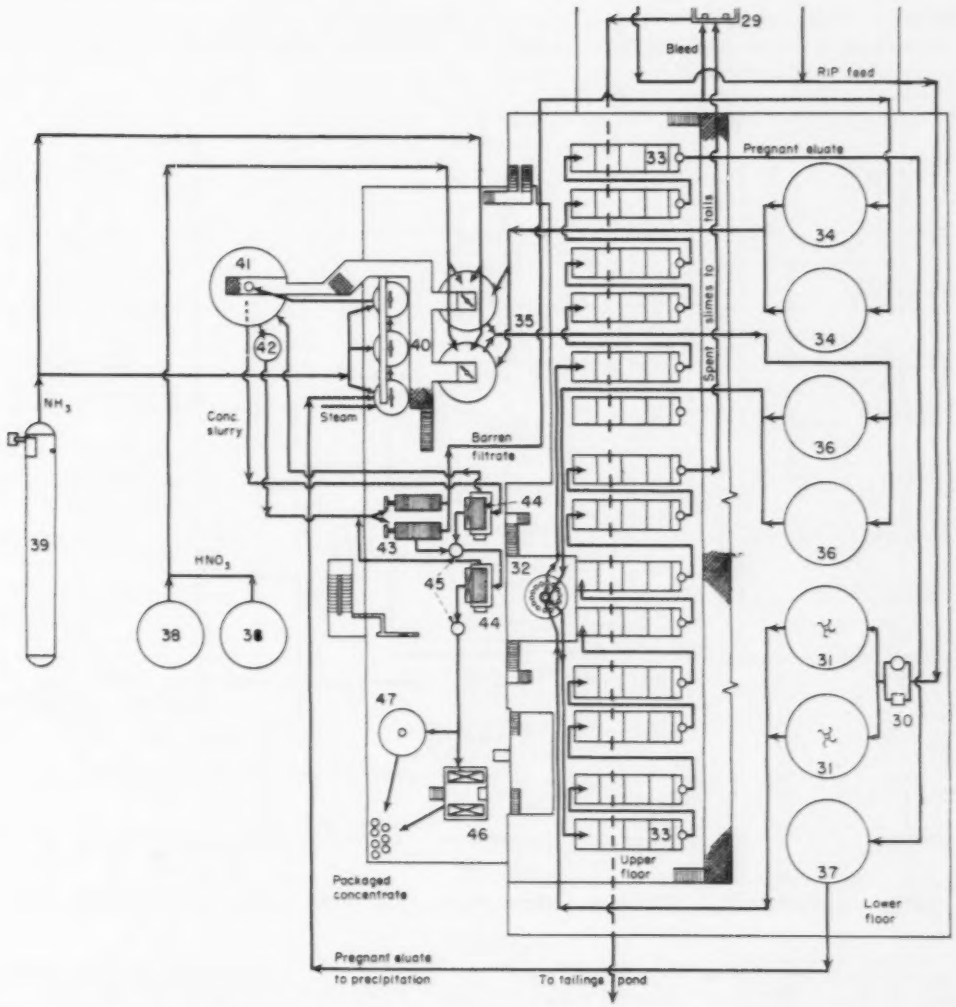
Problem—To treat 1500 tpd of Big Indian area uranium ore. Major mineral is carnotite in a soft friable sandstone. Mill feed at Uranium Reduction Co.'s Moab, Utah operation is 0.3% U_3O_8, but the flowsheet can stand occasional surges to 0.4% U_3O_8.

Solution—



LEGEND

1. 36-in. belt conveyor, with Stearns magnetic head pulley, feeds ore from circular feeding pad
2. Tyler Ty-Rock 5x12-ft rod deck with 2-in. openings
3. Traylor Type H 24x36-in. jaw crusher
4. 30-in. belt conveyor
5. Transfer tower
6. 30-in. belt conveyor
7. Tyler Ty-Rock 5x12-ft vibratory screen with ¾-in. mesh
8. Belt conveyor, 30-in.
9. Nordberg Symons 5½-ft Short Head
10. Three-unit Western Precipitation Dualaire HR4P 4-20-26 dust collector with 21,000 cfm Westinghouse Sturtevant fan and dust return screw conveyor
11. 24-in. belt conveyor

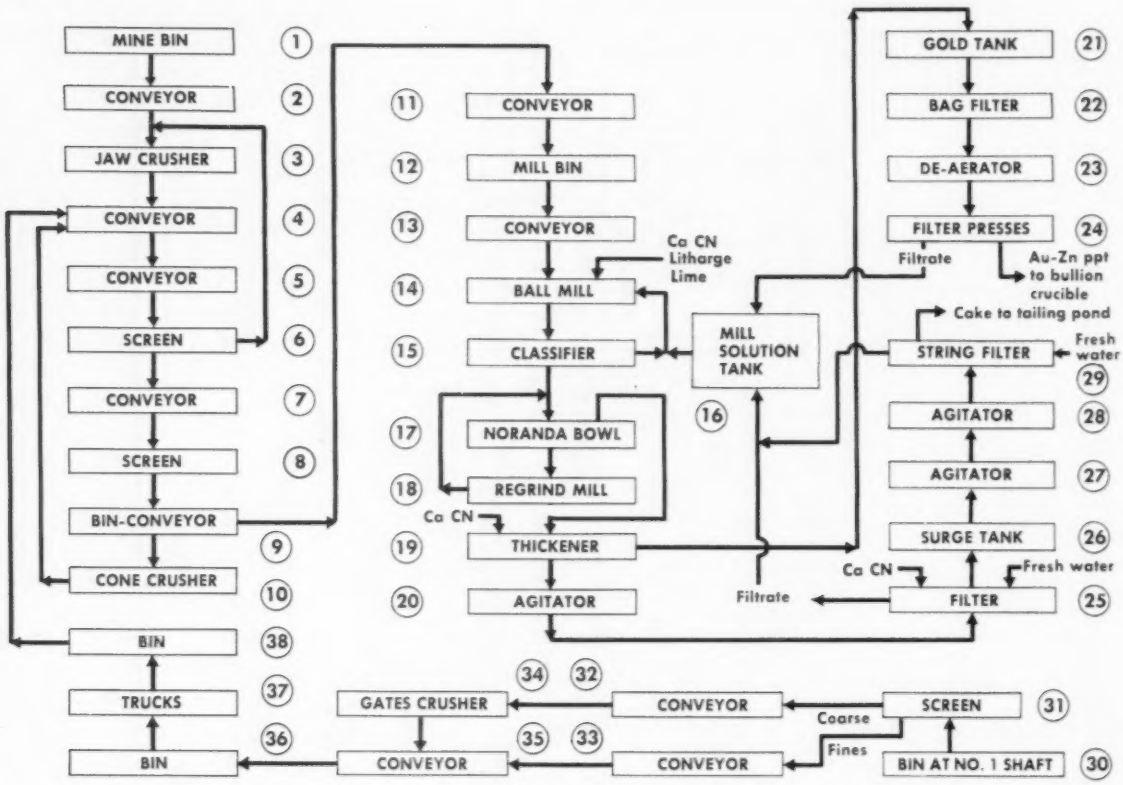


12. Industrial Physics and Electronics scale
13. Sample tower
14. One-unit Western Precipitation Dualaire with dust return screw and 8,000 cfm Sturtevant fan
15. Belt conveyor, 24-in.
16. Ten 300-ton storage bin
17. Ten 24-in. belt conveyors; four 24-in. belts
18. Industrial Physics scale
19. Denver Equipment Co. 7x7½-ft ball mill, 250hp
20. Akins 78-in. spiral classifier
21. Sump with two Wilfley 3-K 25hp centrifugal sand pumps (one standby)
22. Two 1100-ton 40x22-ft storage tanks
23. Ten 24x14-ft Neoprene-lined leach tanks, brick bottom, three agitators each. Desco curved blade, alternate pitch impellers in first two; Turbo-Simplex in other eight
24. Knowles designed Esperanza drag-belt classifiers (16). 38-in. stainless steel blades on two parallel rubber belts
25. Twelve Knowles-designed, locally made 14-in. rubber-lined cyclones
26. Cone thickener, 18x39 ft
27. Cone thickener, 11x20 ft
28. Storage tank (cone bottom, 18 ft dia by 46 ft) and elevator
29. Tailings sump
30. Two 4-ft Sweco Separators and two 4x8-ft Robbins vibrating trash screens. All have 35-mesh cloth
31. RIP pregnant storage tank, 22x12-ft with agitator
32. Stainless steel flow distributor
33. RIP tanks, 28, each having four 6x6x6-ft stainless steel baskets with 28x8-mesh cloth (Tyler 147). Airlift flow between tanks
34. Barren eluate tanks, 22x12-ft
35. Regeneration tanks, 16x10-ft
36. Regenerated eluate tanks, 22x12-ft
37. Pregnant eluate storage tank 22x12-ft
38. Nitric acid storage. Two 191-ton tanks
39. Ammonia storage, 30,000 gal capacity
40. Precipitation tanks, 10x10-ft
41. Yellow cake thickener, 20x14-ft
42. Thickener overflow tank, 8x8-ft
43. Shriver plate and frame filter press, 24 one-inch wooden chambers
44. Two Peterson 4x4-ft stainless drum filters
45. Yellow cake repulp tank, 6x6-ft
46. Twin drum dryer, 32x72-in.
47. Skinner 6-ft dia, 6-hearth dryer

Results— Resin-in-pulp successfully recovers 90% of the uranium in the raw ore. Finished concentrate analyzes about 70% U_3O_8. Direct operating costs are about $10 a ton of ore, in spite of high trucking costs from area mines to the mill. Resin-in-pulp is widely adaptable to a variety of ores, according to E. C. Bitzer who served as metallurgical consultant for Uranium Reduction Co. — Source *E&MJ*, January 1957.

Problem— To produce gold from a free milling quartz rock found at Belleterre, Que. Belleterre Quebec Gold Mines Ltd. decided on a straight cyanide flowsheet at 400 tpd ore, 0.2 to 0.3 oz per ton ($7 to $9 rock).

Solution—



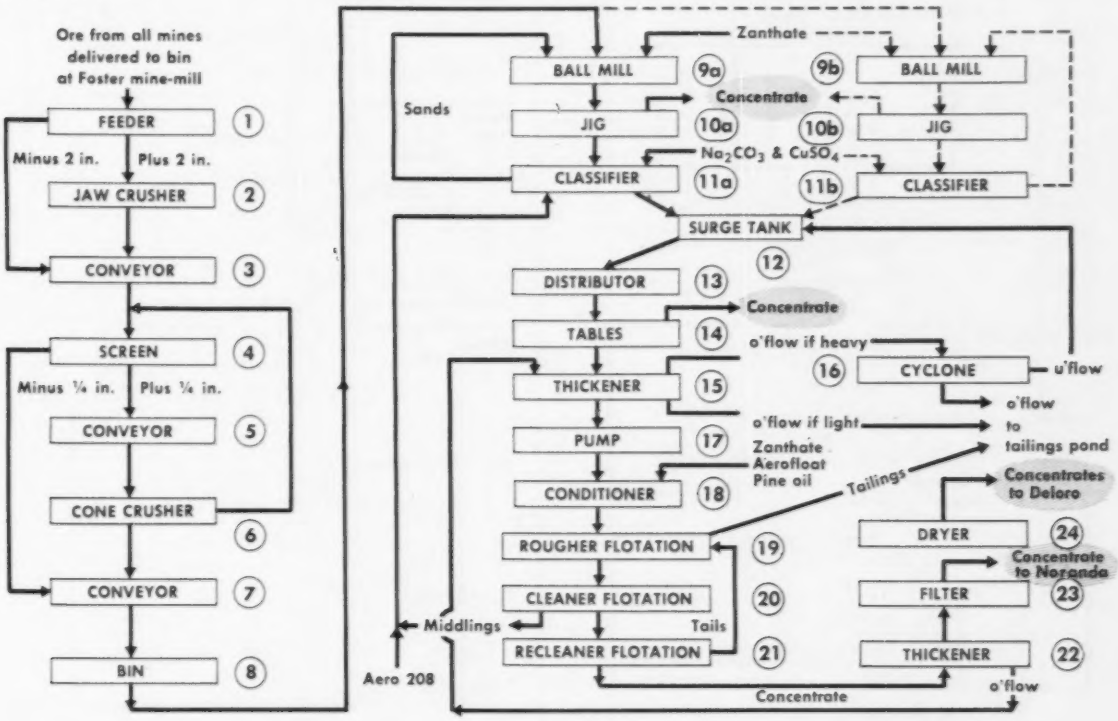
LEGEND

1. 80-ton bin at one shaft. Production and development ore is drawn from two of three shafts
2. Conveyor feeds to jaw crusher
3. Traylor 15x24 in. jaw crusher breaks to 1 in.
4. Conveyor transfers crusher discharge to screen conveyor
5. Screen conveyor
6. Single deck Niagara screen, 3x6 ft with 2 in. openings
7. Conveyor feeds undersize to next screen
8. Double deck Dillon screen, 4x8 ft, screens at ¼ in.
9. Conveyor delivers plus ¼ in. to secondary crusher bin
10. Plus ¼ in. from screen feeds to a 4-ft Symons Short Head crusher set at ¼ in.
11. Conveyor delivers minus ¼ in. feed to 800-ton mill bin
12. Mill bin
13. Conveyor
14. Dominion ball mill, 5x12 ft, with 2½ in. balls
15. Dorr rake classifier, 6x28 ft, closes the ball mill. Mill solution, cyanide, litharge and lime added
16. Mill solution tank collects filtrate and wash from all filters
17. Noranda bowl classifier (Geco), 10 ft dia
18. Regrind mill is Marcy 5x5 ft
19. Overflow from Noranda bowl enters a 24x10 ft Dorr double tray thickener which overflows to the gold tank. CaCN added
20. Underflow from double tray enters an 18x8 ft Dorr agitator
21. Gold tank collects pregnant solution
22. Pregnant liquor is clarified in a bag filter
23. De-aerating tower maintains 25 to 26 in. vacuum and constant level with the aid of an Ingersoll-Rand Type 30 pump
24. Two Perrin 28-leaf filter presses under lock and key. They are opened about once a month to remove Au-Zn cake which goes into the laboratory for purification to bullion
25. Oliver 8x8 ft filter takes agitator discharge from No. 20 for washing step. CaCn added
26. Filtrate from Oliver goes to mill solution tank, while cake is discharged and repulped in a surge tank
27. Pulp flows to another 18x8 ft Dorr agitator
28. Pulp enters still another 18x8 ft Dorr agitator
29. Pulp is washed and filtered on a Feinc string filter. Each string has its own eyelet. Filtrate goes to mill solution tank. Cake is repulped and sent to tailings pond
30. Ore sent up No. 1 shaft is stored in an 80-ton bin
31. Jeffrey vibrator feeder-screen feeds fines to conveyor No. 33 and coarse to conveyor No. 32
32. Conveyor to crusher
33. Fine conveyor
34. Gates crusher, 7½ ft
35. Conveyor delivers crusher and fine screen discharge to bin
36. Bin holds 40 tons
37. Trucks deliver to mill
38. Trucks dump into 10-ton bin feeding onto conveyor No. 4

Results— Using ¼ lb of CaCN per ton, 60 lb of litharge and 300 lb of lime a day, Belleterre Quebec operates at a profit, leaving only 0.002 to 0.006 oz gold per ton in the tailings. Not much mineable ore remains.

Problem—To recover silver and cobalt from Cobalt, Ontario, camp. Cobalt Consolidated Mining Corp. Ltd. operates five mines and maintains separate stockpiles for ore—cobalt; silver; joint-ownership; and large low-grade lumps from bonanza days. Mill runs each stockpile separately, except the fourth which is added to the first two to balance mill tonnage at 300 tpd. Second ball mill and classifier circuit may be added in the future to raise tonnage to 500 tpd. Mill was designed by Harry E. Cawley, engineer and mill superintendent.

Solution—



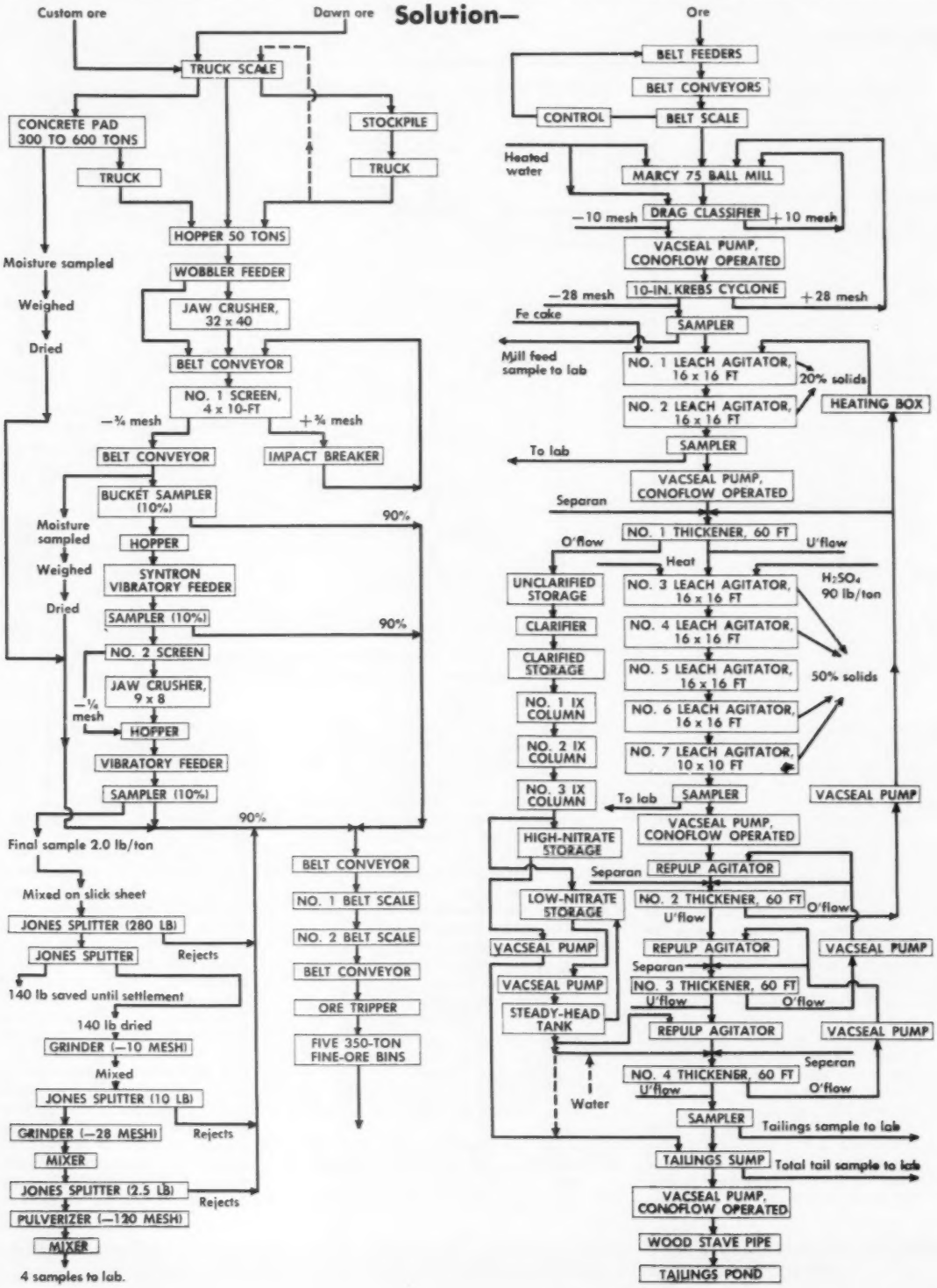
LEGEND

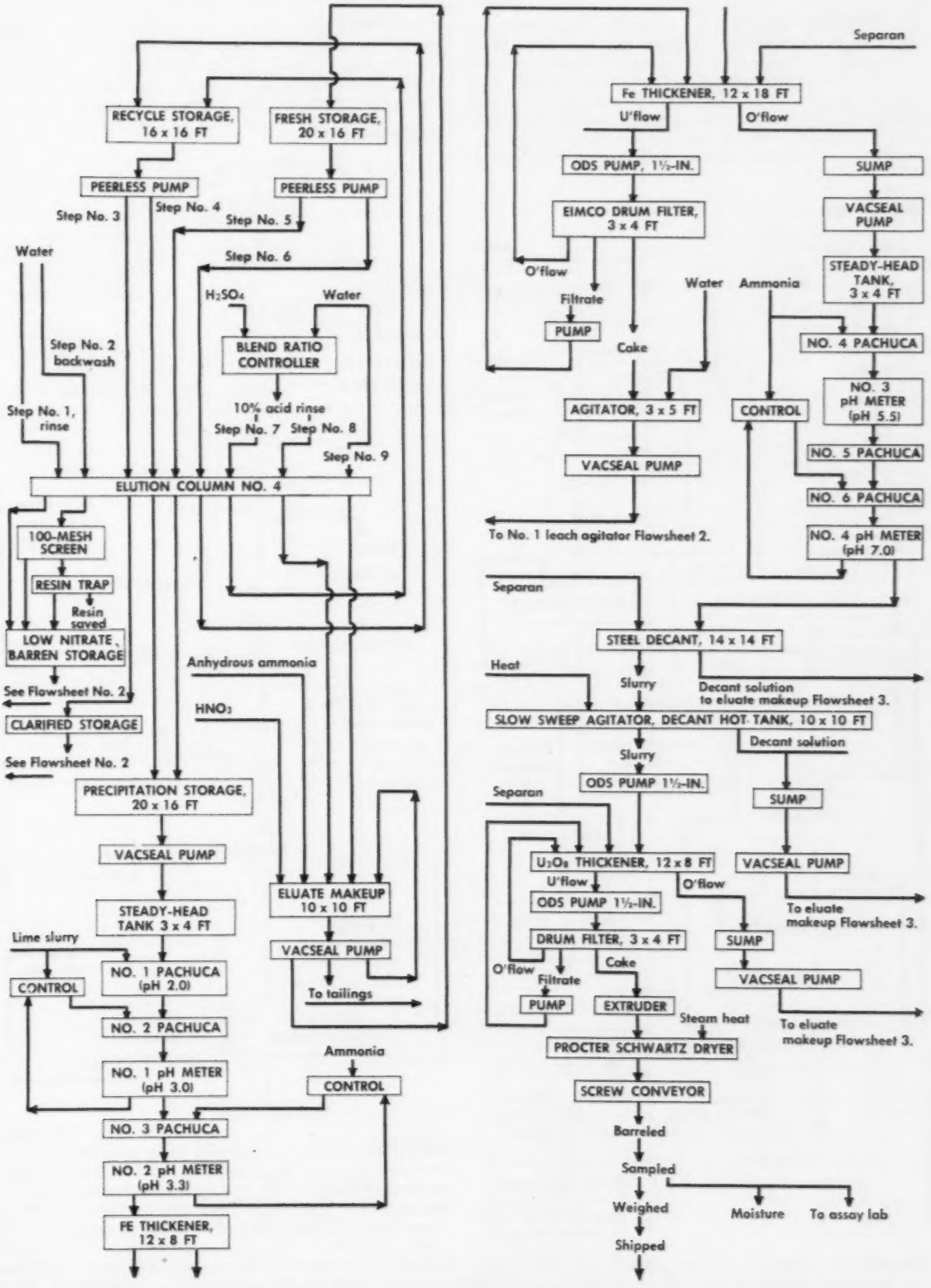
1. All ore from the five mines operated by Cobalt Consolidated comes to a bin at the Foster mine-mill and is delivered to stockpiles which keep cobalt ore separate from silver ore. A third stockpile holds Christopher mine production which is milled separately due to joint ownership. Fourth stockpile holds much low-grade silver ore which is used to balance mill feed tonnage
2. Plus 2-in. feed from the feeder-screen is broken in a 15x30 in. Dominion jaw crusher
3. Minus 2 in. by-passes crusher to a 24-in. conveyor belt
4. Dillon 4x10-ft vibratory screen with 4-mesh cloth
5. Plus ¼ in. goes by 24-in. conveyor under a magnet to the cone crusher
6. Symons 4-ft Short Head cone crusher
7. Conveyor belt, 24 in.
8. Bin holds 550 tons
9a. Hardinge 4x8 ft ball mill in closed circuit with a 5x5 SRL pump feeding the jib and the classifier. Zanthate is added. Circuit 9b is to be installed later. Mill uses 4 in. balls
10a. Denver 16x24 in. mineral jig makes a silver concentrate which is collected in a wheelbarrow and delivered to the dryer. 10b will be added later
11a. Akins 60-in. spiral classifier closes the ball mill. Sodium carbonate and copper sulphate added. Circuit 11b will be an Akins 48-in. screw
12. Classifier overflow is delivered by 6x6 in. SRL sand pump to surge tank
13. Denver distributor, 3 in. Pulp is 30% solids at 65% minus 200-mesh
14. Four Wilfley shaking tables produce a high-grade silver-cobalt concentrate which is wheelbarrowed to the dryer. Table tails feed to thickener
15. Dorr 30x10 ft thickener overflows two ways—if heavy to cyclones; if light direct to tailing line. Thickened underflow is pumped to conditioner
16. DorrClone is 6 in., sends overflow to tailing line and underflow back to surge tank
17. Denver 5-in. diaphragm pump
18. Conditioner, 8x8 ft, where Zanthate, Aerofloat and pine oil are added
19. Conditioned pulp enters No. 3 cell of an 8-cell bank of Denver No. 24 in. roughers. Concentrate overflows from 3-through-8 forward to No. 2. Overflow from No. 2 enters No. 1, which produces a rougher concentrate
20. One Denver No. 24 cleaner cell produces a cleaner concentrate and a middling which returns to the Akins
21. One Denver No. 24 makes a recleaned concentrate. Tails return to the roughers
22. Thickener, 10x10 ft whose overflow goes to No. 15
23. Denver 4-ft dia disc filter with three leaves. Concentrate is shipped at 10% moisture as a low-grade cobalt-silver-copper concentrate to Noranda
24. Dryer is an oil-fired 3x20 ft Ruggles-Coles fitted with dust collector. High-grade silver concentrate from the jigs and tables is dried, then sent to Deloro Smelting & Refining Co. Ltd. in 1200-lb drums. High-grade silver plate, lump and wire are hand-picked, bagged and shipped separately. In 1956, 31 tons of hand-cobbed high-grade were shipped assaying from 3,000 to 7,000 oz Ag per ton.

Results—Silver recovery is 95% at about $2 a ton milling cost. Three concentrates are produced—high-grade hand-cobbed lump, wire and plate; high-grade jig and table concentrates, and low-grade flotation product.

Problem—To recover uranium from ores in the Spokane Indian Reservation in Dawn Mining Co.'s 440-tpd mill at Ford, Wash. Ore occurs on a north-south contact between granitic and metamorphic rocks, altered or unaltered depending on locale. Mineralization is mostly autunite at Midnite mine, occurring in three distinct types—highly altered schist, altered granite, and unaltered schist which holds the highest grade ore. Only minor amounts of other uranium minerals are present. Custom ore contains autunite and uranothorite.

Solution—

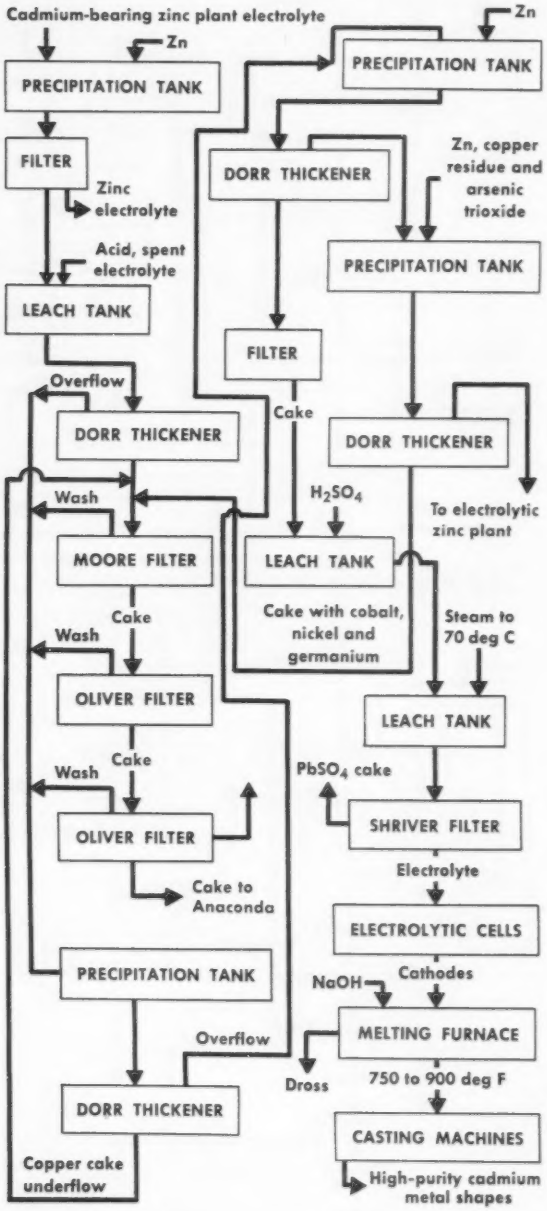




Results— Split circuit above permits 96% extraction and recovery of the uranium. Final precipitate is recovered as ammonium diuranate which meets the AEC's specification. —Source *E&MJ*, March 1958.

Problem— Recovery of cadmium from electrolyte going to the electrolytic zinc plant at Great Falls, Mont. Anaconda Co. installed the following flowsheet based upon the electromotive series of metals. Cadmium and other metals are recovered. Cadmium is redissolved in acid, purified further and sent to cadmium electrolytic refinery for purification. Refined cathodes are then melted in a furnace and cast into desired shapes automatically or by hand.

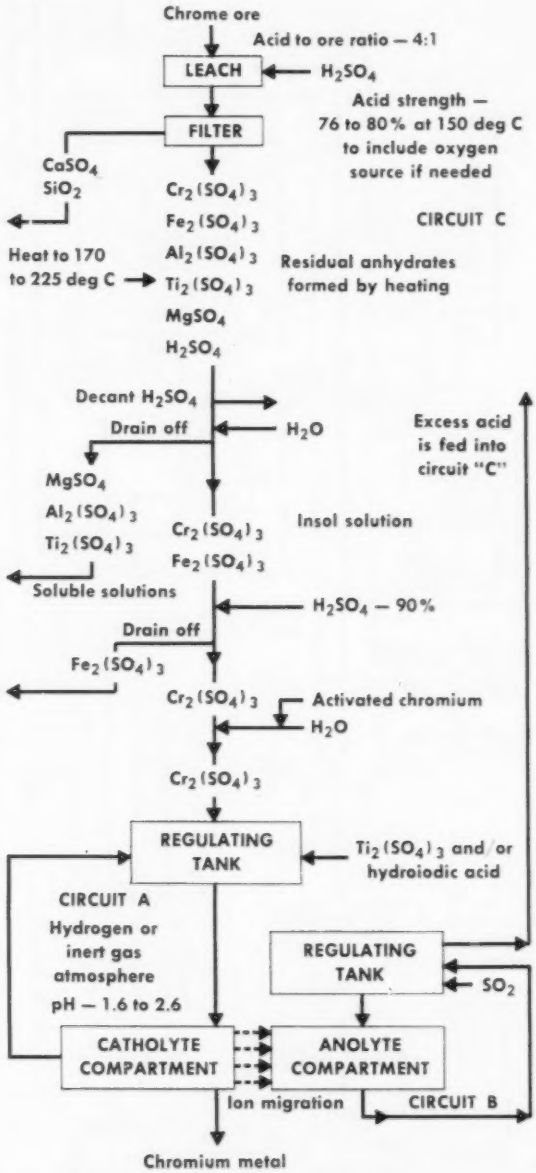
Solution—



Results— Cadmium, copper, cobalt and germanium are separated, recovered and refined. Purified electrolyte goes to zinc plant for electrolytic zinc production.—Source A. L. Alf at 1958 annual AIME meeting.

Problem—To produce electroyltic chromium from chrome ore. Suggestion and patent were made by G. C. Westby and assigned to Key Metals Corp. Patent No. 2,803,594. Sulphuric acid is used to leach, then regenerated in the electrolytic cell for re-use.

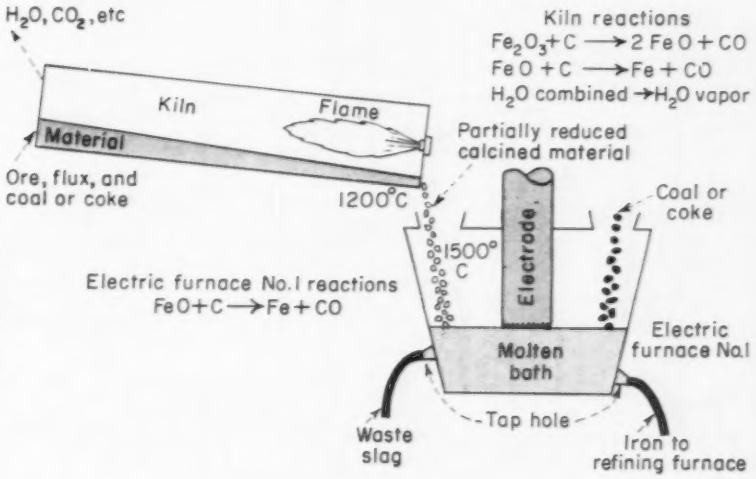
Solution—



Results—Process is reported to be suitable for chromite-ilmenite-rutile beach sands as well as chromite. High-purity chromium results, and a titanium-bearing residue is obtained as a by-product. Tests were performed on black sands from Bandon, Ore. Concentrate assayed 43.3% Cr_2O_3 and 26.5% Fe. Tests showed that 94% of the contained chromium was extracted as anhydrous $Cr_2(SO_4)_3$. One key item in the patent is the addition of scrap chromium metal to the cathode compartment to prevent side reactions.—Source *E&MJ*, December 1958.

Problem—To produce iron by reduction of the ore, with slagging agents, in an electric furnace. The Strategic-Udy Process for direct reduction of iron ore was developed by Marvin Udy of Strategic-Udy Metallurgical & Chemical Processes, Ltd. (Sumac), Niagara Falls, Ontario, a subsidiary of Strategic Materials Corp., Buffalo, N.Y. Pilot plant work has been done by Sumac and Koppers Co., Pittsburgh, Pa. Process is reported to be suitable for any size operation—100, 500, 1,000 tpd. There is no contention that the process is competitive with the blast furnace. For other direct reduction processes, see *E&MJ*, December 1957.

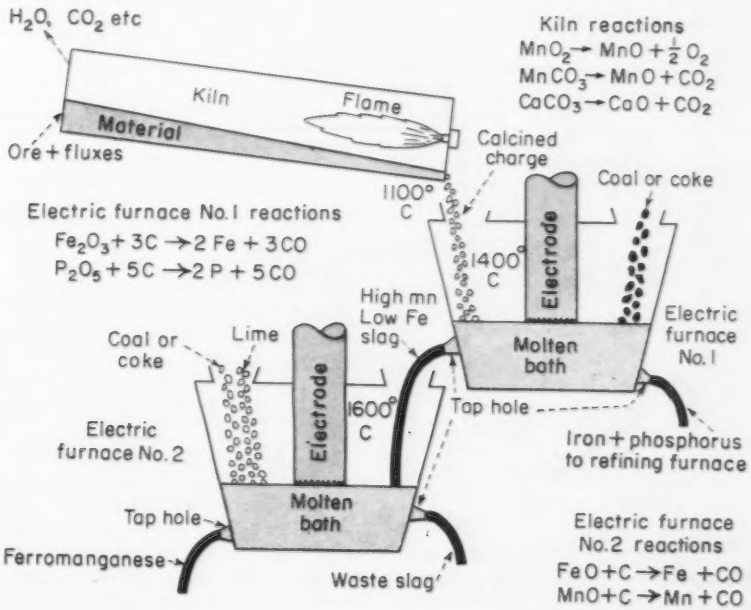
Solution—



Results—Product is a pig iron; not a nodule, sponge, iron powder or flake. In reasonably priced power areas, the developers feel that this method would be a good supplemental production unit, or a low capital cost unit for smaller-than-blast-furnace capacity.—Source Sumac.

Problem—To produce ferromanganese by a two or three stage electric furnace process, using low-grade Woodstock, New Brunswick ore, coal or coke, lime and a calcined ore. Strategic-Udy and Koppers Co. have been making pilot runs at Niagara Falls on ferromanganese production. Some time this year, they expect to run some of Gunnar Uranium's chromite through the pilot plant in an attempt to prove a process for the production of ferrochrome. Udy Ferromanganese Process is a two or three step affair, with reagents and conditions changing in each electric furnace. Manganese ore and a flux react in first furnace to produce a high manganese slag and a low-phosphorus pig iron. Slag is tapped to second furnace where a trace amount of calcium carbide acts as reducing agent, and a low or medium carbon ferromanganese is produced.

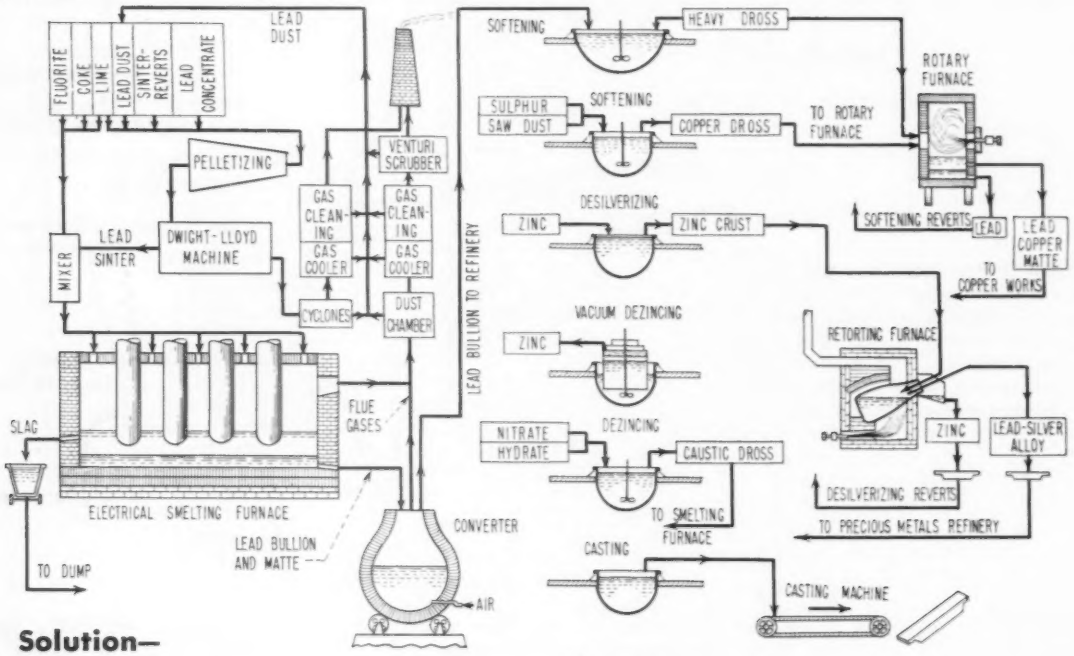
Solution—



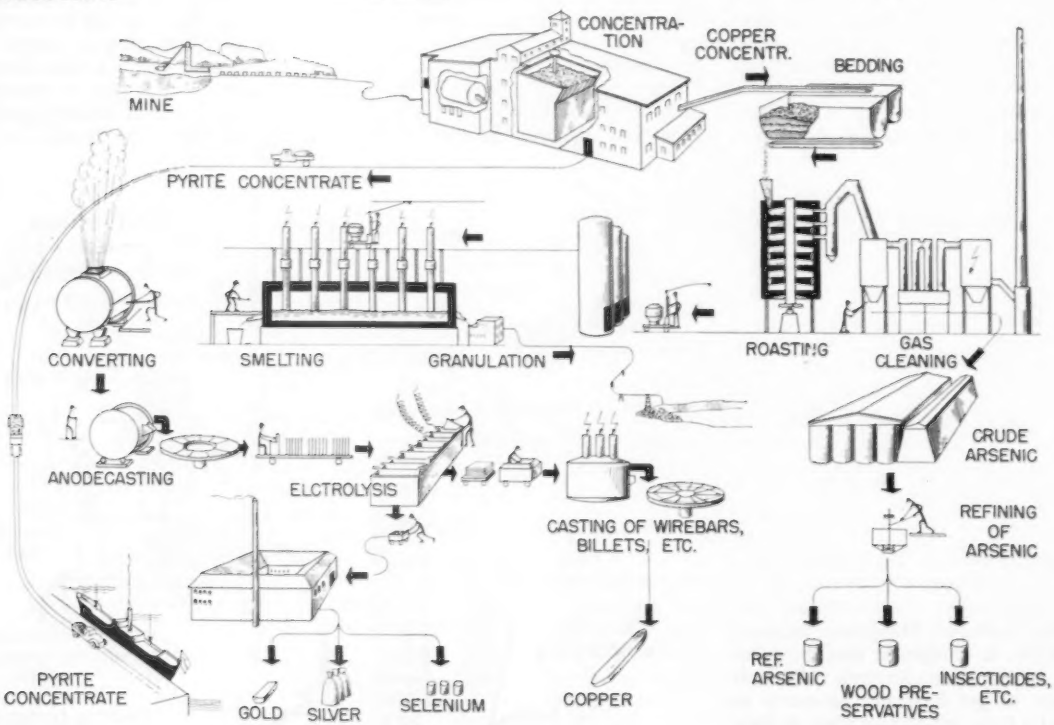
Results—The Udys report that the power factor is 95% with power consumption at 3500 kwh per ton FeMn produced. Manganese recovery is 95%. It is believed that the process is economic. Strategic Materials hopes to get financing necessary to build a large production plant at their Woodstock, New Brunswick, manganese deposit.—Source Strategic Materials Corp.

Problem—To smelt lead concentrate running 80% Pb and 13.5% S in an electric furnace to produce some 26,000 tpy lead; also to use electric smelting on copper concentrate, treating 175,000 to 200,000 annual tons of concentrate and ore. Boliden Mining Co., Skelleftea, Sweden, developed these two flowsheets.

Solution—



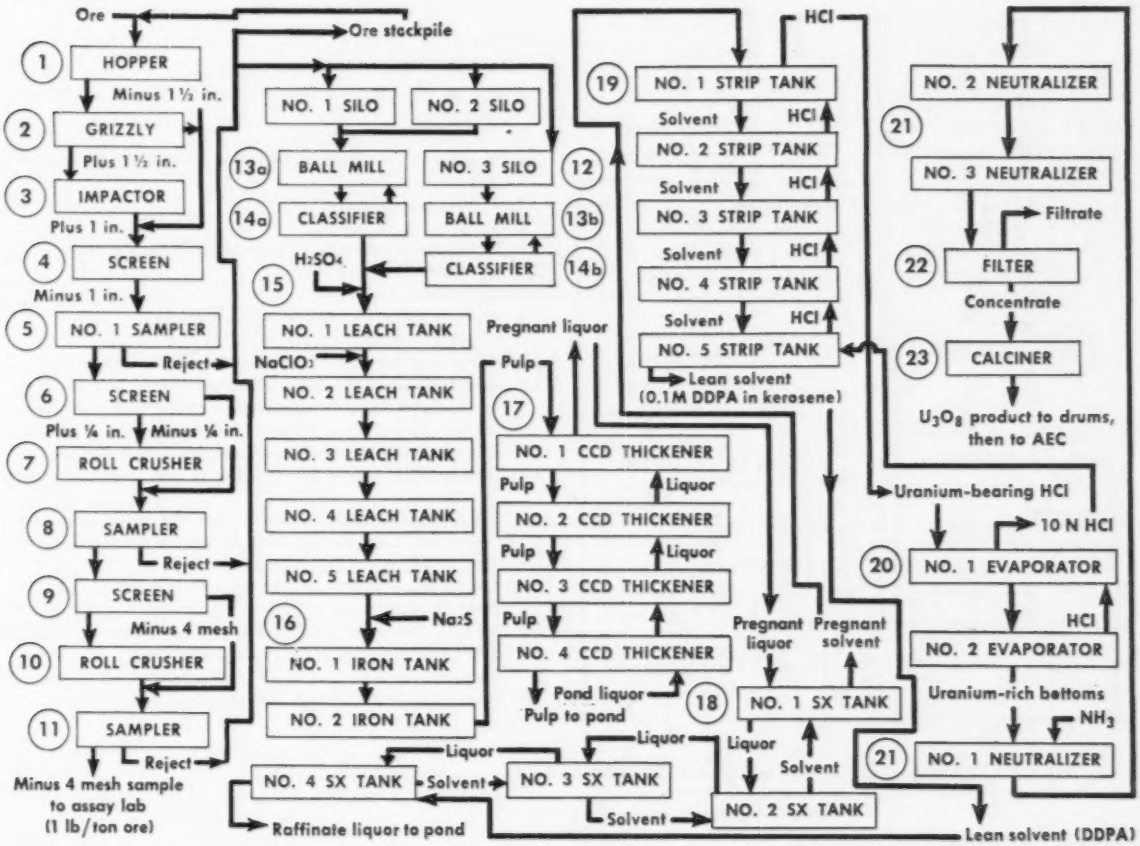
Solution—



Results—One 12,000 kva electric furnace smelts up to 200,000 tons of copper concentrate and ore a year. One 4,000 kva electric furnace smelts all the lead calcine.—Source *E&MJ*, January 1955.

Problem—To reduce operating costs and get a better extraction of uranium from company-owned and custom ores milled at Vitro Uranium Co., Salt Lake City, Utah mill. Vitro converted to solvent extraction from the old phosphate precipitation flowsheet (see *E&MJ*, September 1955), added their own crushing and sampling plant and a new process development department. The new method saves money, says W. B. Hall, Vitro Uranium president, because reagents are less costly, the process lends itself to automation, and it has a better recovery method. Another advantage of solvent extraction is that it is more flexible in treating a variety of ores.

Solution—



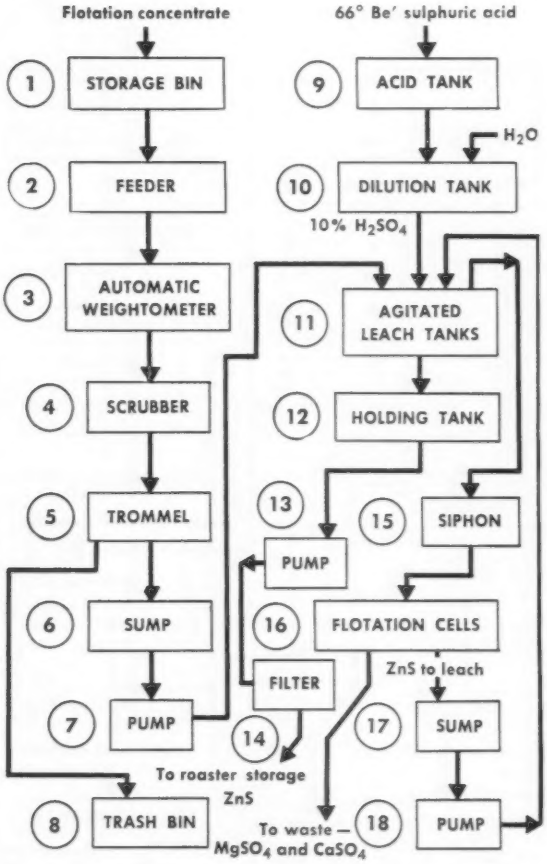
LEGEND

1. Railroad cars deliver ore from various mines to Salt Lake City where it is fed into 50-ton hopper. All new mine ore goes through sample plant, and any ore with-drawn from the stockpile must pass through the sample plant again
2. Grizzly with 1½ in. openings
3. Cedar Rapids 30x30 in. impact crusher
4. Hummer screen, 1-in. openings
5. No. 1 sampler takes 10% cut, sends remainder of feed to silos or stockpile
6. Hummer screen, ½-in. openings
7. Roll crusher, 14x30 in.
8. Second sampler takes 10% cut; reject goes to silos or stockpile
9. Hummer screen, 4-mesh cloth
10. Roll crusher set at 4-mesh discharge
11. Final sampler takes 5% sample of minus 4-mesh fraction to laboratory for assay (1 lb/ton ore feed). Reject passes to silos or stockpile
12. Three silos store ore for mill feed. No. 1 and 2 hold 900 tons, No. 3 holds 500.
13a. Eimco 6x6 ft ball mill. Pulp at 50% solids
13b. Marcy 6x4½ ft ball mill. 50% solids
14a. Model C, Dorr rake classifier, 54 in.
14b. Akins 48-in. dia spiral classifier
15. Five leach tanks, approximately 10,000 gal capacity each, in series. H_2SO_4 is added to first; $NaClO_3$ to second; and Na_2S to discharge of No. 5
16. Iron tanks—two tanks where iron reduction takes place to prepare the solution for solvent extraction
17. Four 70-ft dia Dorr-type thickeners in countercurrent arrangement. Pond water and fresh water are used to produce the pregnant liquor
18. Four solvent extraction tanks in countercurrent series. Barren raffinate goes to pond. Rich solvent goes to solvent strip section
19. Five-stage countercurrent HCl stripping tanks. 10 N HCl used. Lean solvent moves forward to SX section
20. Two-stage HCl evaporators recover HCl. Uranium-rich bottoms go to neutralization. Evaporators are made up of Karbate pipe and tube heat exchanger sections to form a falling film type evaporator
21. Three-stage agitated neutralization tanks. NH_3 added to No. 1
22. Eimco string-discharge vacuum filter
23. Calciner

Results—Vitro is so pleased with the ease of operation and the degree of automation possible with solvent extraction that it has written solvent extraction into the 1,000-tpd Gas Hills, Wyo. mill contract now being considered by the AEC. The AEC has announced expansion goals in that area.—Source *E&MJ*, May 1958.

Problem—To remove magnesium ions from electrolytic zinc solutions to prevent interference during electrolysis. Bunker Hill Co. decided to leach out the acid-soluble magnesium from the flotation concentrate before the concentrate is roasted to the oxide. Sulphide concentrate contains enough magnesium to interfere. Leaching the sulphide concentrate reduced the magnesium content to a satisfactory level. For more details, see results below.

Solution—



LEGEND

1. Storage bin 9 x 10 ft, steel, 35 ton capacity
2. Feeder, 36-in. belt. Link-Belt with Pacific gearmotor — 3 hp, 13.5 rpm
3. Weightometer, Merrick 24-in.
4. Scrubber, 6 x 4 ft conical ball mill by Hardinge on 30 hp, 875 rpm
5. Trommel to remove trash
6. Sump
7. Pumps — two — 4 x 3-in. 250 gpm Vacseals by Galigher; General Electric 25 hp motor
8. Trash bin
9. Acid storage tank for 66° Be' sulphuric acid; 2½ x 5 ft steel, 197 gal capacity from Union Iron Works
10. Acid dilution tank, 10 x 5 ft lead-lined steel from Union Iron Works
11. Leach tanks — total four. 20 x 13 ft from National Tank and Pipe Co. Agitators by Union Iron Works with U.S. Varidrive motors (15 hp)
12. One wooden stave holding tank from National Tank and Pipe Co.
13. Pump is Galigher 2½ x 2-in. Vacseal, 45 gpm; General Electric 10 hp motor
14. Filter is 8 x 12 ft drum by Eimco Corp. with Reeves vari-speed motordrive, 2 hp. Vacuum pump is Ingersoll-Rand Type E-S-1 with 30 hp General Electric motor
15. Tank siphons — eight — two to each leach tank. Each is 3-in. dia with 10 ft effective depth
16. Flotation cells — two — Agitair No. 18 from Galigher Co. Drive is 10 hp General Electric Co. motor on 875 rpm
17. Sump
18. Pump is Galigher 2½ x 2-in. Vacseal

Results—Magnesium interferes with the electrolysis of zinc from zinc sulphate solutions because magnesium ion builds up in the electrolytic solution. Cathodes produced with much magnesium in the electrolyte show poor metal deposition and poor current efficiencies. Bunker Hill attacked the problem both in the mill and in the refinery.

They found that grinding concentrate to 91% minus 325 mesh reduced MgO and CaO content of the cleaner flotation concentrate by 33%. At the same time, percentage of zinc in the concentrate went up from 53.2 to 55.8% Zn.

Next step toward improved Special High production was the leaching system installed to treat 200 tpd of flotation concentrate. Concentrate is slurried in a ball mill at 50% solids, then leached at 40% solids with 10% solution of 66°Bé sulphuric acid. $MgCO_3$ and $CaCO_3$ react by ion exchange with the acid to produce insoluble $CaSO_4$ (gypsum) and soluble $MgSO_4$:

$$MgCO_3+CaCO_3+2H_2SO_4 \rightarrow MgSO_4+2CO_2+H_2O+\underline{CaSO_4 \cdot 2H_2O}\downarrow$$

Leached pulp is agitated slowly to allow heavy zinc sulphide to settle out with the gypsum on top, then the liquor is decanted with a siphon and filtered. Concentrate is repulped several times to remove all the gypsum and soluble magnesium sulphate. Clean concentrate is filtered and sent to the roasting plant.

Roasting of a zinc concentrate takes place as the following ion exchange between zinc sulphide (solid) and oxygen (gas), a solid-gas ion exchange:

$$ZnS+PbS+3O_2 \rightarrow ZnO+PbO+2SO_2\uparrow$$

Calcine is leached with dilute sulphuric acid to produce soluble zinc sulphate and insoluble (in hot solution) lead sulphate, which are separated by filtration:

$$PbO+ZnO+2H_2SO_4 \rightarrow ZnSO_4+2H_2O+PbSO_4\downarrow$$

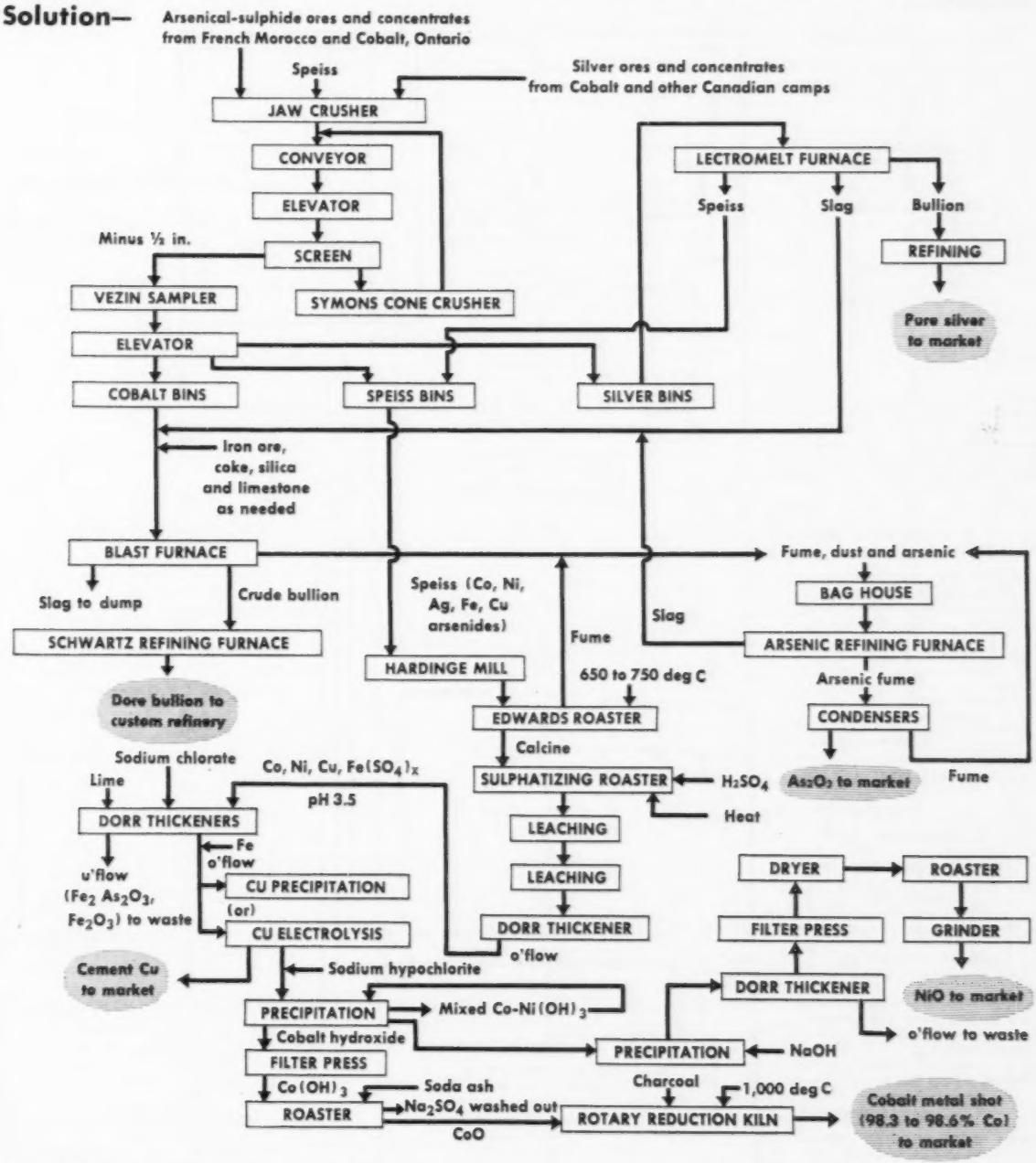
In the electrolysis, the zinc ion migrates to the cathode and collects electrons to become metal:

$$Zn+2e \rightarrow \underline{Zn^\circ}\downarrow$$

With these techniques, Bunker Hill Co. is able to treat the high dolomitic lead-zinc ores now being found at the mines. About 21.8 tons of magnesia are leached out of the sulphides each month, leaving the electrolyte with only 15 gm/l of MgO (about half of former amount).—Source W. Schmittroth, superintendent, Bunker Hill Co., Kellogg, Idaho, "Removal of Magnesia and Lime From Dolomitic Type Zinc Concentrate", presented at 1958 AIME annual meeting.

Problem—To smelt, on a custom basis, high arsenical-sulphide cobalt and silver concentrates and ores from Cobalt, Ontario, speiss from Eldorado, N.W.T., and other Canadian ores in addition to cobalt ores from French Morocco. Deloro Smelting & Refining Co. Ltd., Deloro, Ontario, developed this solution. Canadian cobalt materials generally assay, per ton, 100 to 900 oz Ag, 11% Co, 9% Ni, 1% Cu, 31% As, and 10% S. French Morocco ores generally run 6 oz Ag, 9.6% Co, 0.3% Ni, 0.1% Cu, 43% As, and 1.7% S. Canadian silver concentrates from the Cobalt camp run 2,500 oz Ag, 5.5% Co, 1.1% Ni, 0.1% Cu, 11.5% As ad 3% S.

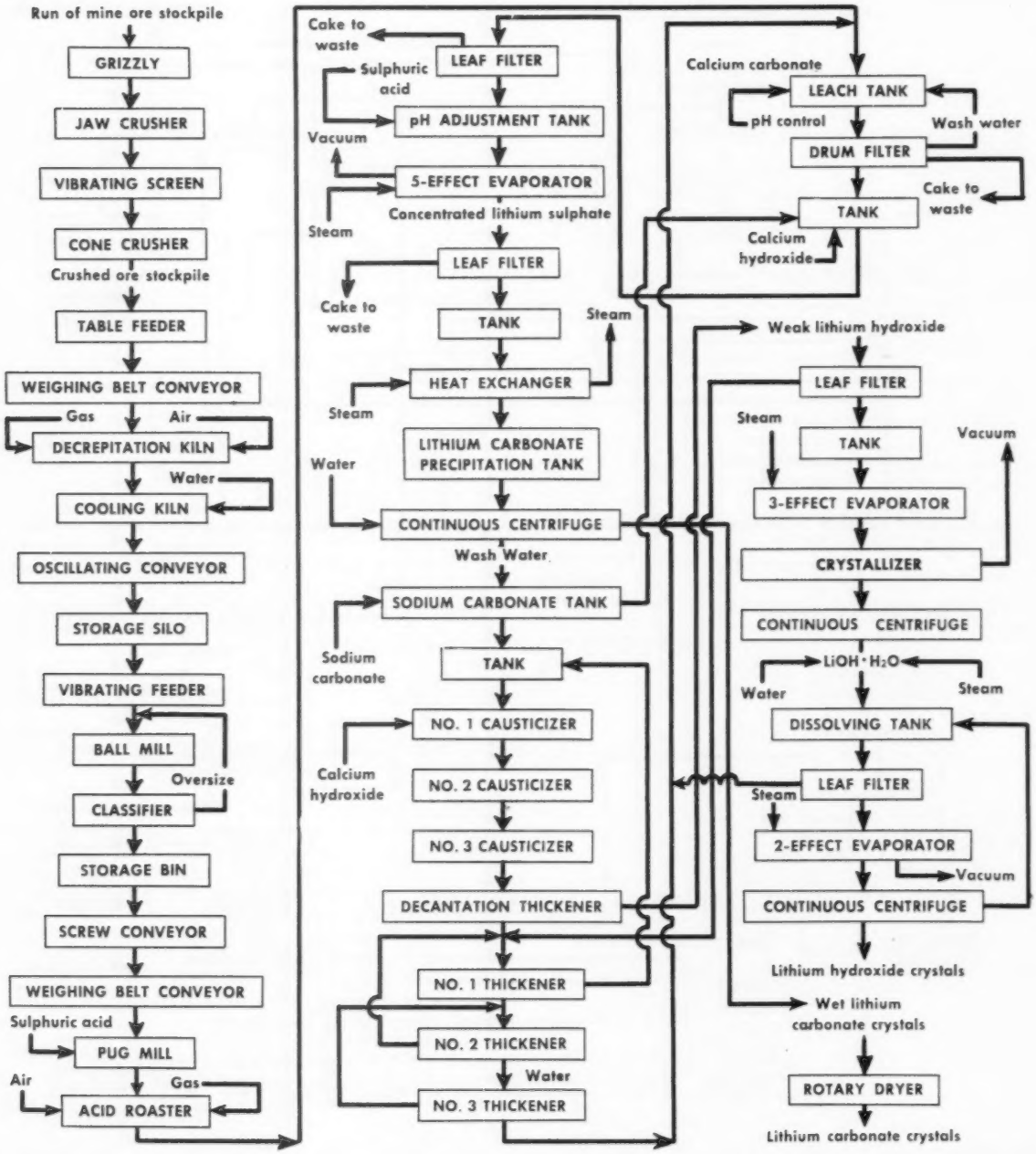
Solution—



Results—Deloro successfully treats those high arsenical-sulphide ores not generally acceptable any place else in Canada—without Deloro, the Cobalt camp would have no outlet for the cobalt-nickel-copper-silver complex. Deloro produces six products as shown—silver, NiO, cement copper, CoO, Co, refined arsenic, and a Dore bullion. Some finished cobalt is used at Deloro's Stellite Alloy works in Canada and the U.K., some goes to Canadian markets and the rest is exported. Deloro has in the past done some custom smelting for the U.S. strategic stockpile program.—Source *Cobalt in Canada*, by R. J. Jones, Mines Branch Publication No. 847, Department of Mines and Technical Surveys, Ottawa, Province of Ontario, Canada.

Problem—To recover and refine lithium chemicals from spodumene occurring in the lithium spodumene belt of Kings Mountain, N.C., and at Val d'Or, Quebec. Lithium Corp. of America developed a process, shown below, to handle Kings Mountain ore at about 1.3% Li_2O. Process operated successfully. When Quebec Lithium Corp. discovered their Val d'Or deposit, Lithium Corp. of America agreed to take nearly all the Quebec flotation concentrate to sweeten the feed to refinery at Bessemer City, N.C.

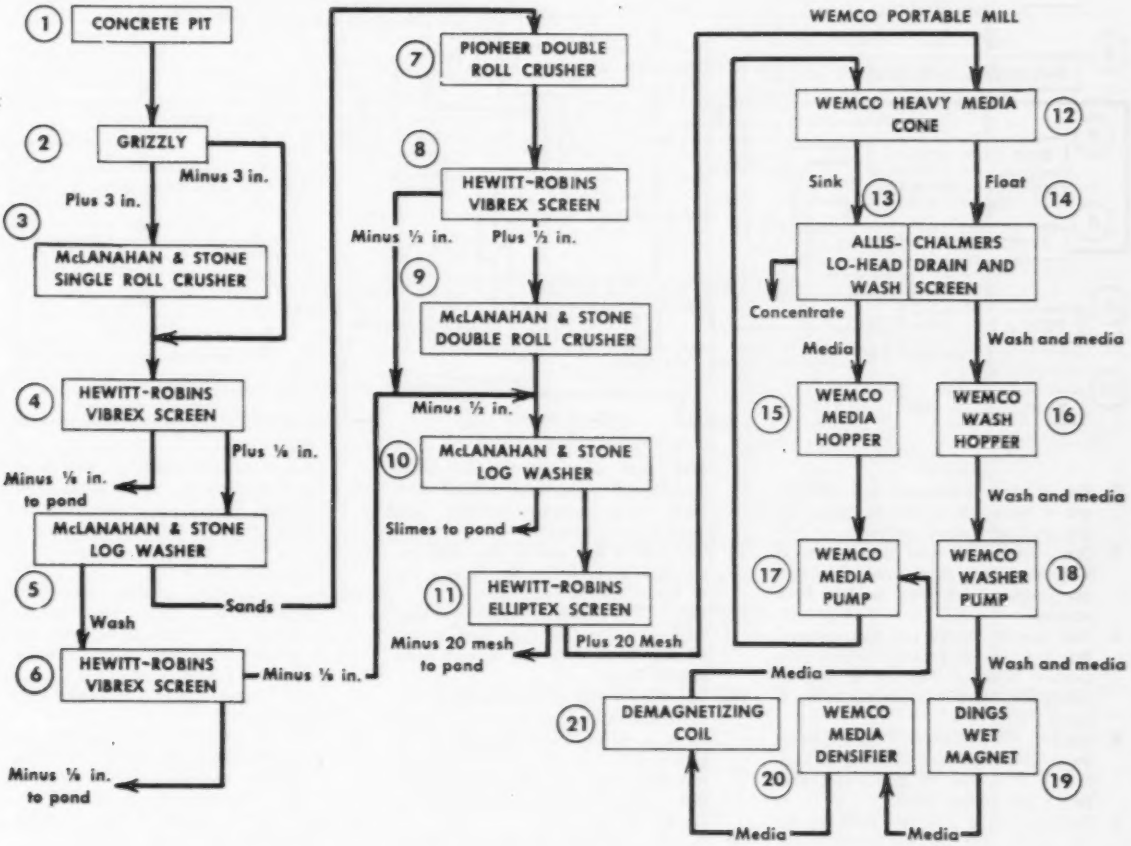
Solution—



Results—Lithium Corp. of America gets two refined chemicals from the process—mostly lithium hydroxide to satisfy Government contract, and some lithium carbonate for civilian market and metal production. Lithium hydroxide for the Government is treated to extract part of the Li-6 isotope; the residue, still in the hydroxide form, being held indefinitely for Lithium Corp. of America which must take it back.—Source *E&MJ*, September 1955 and later releases by Lithium Corp. and the U.S. Atomic Energy Commission.

Problem—To mine and mill a tough, sticky manganese nodular ore in the western foothills of the Blue Ridge Mountains, Vesuvius, Va., South River Mining Co. developed a screening, log washing, crushing and heavy media separation process as shown below. Specific gravity in the Wemco cone separator is established at 3.3 with ferrosilicon. Media cleaning circuit consists of an electromagnet, densifier and demagnetizer.

Solution—



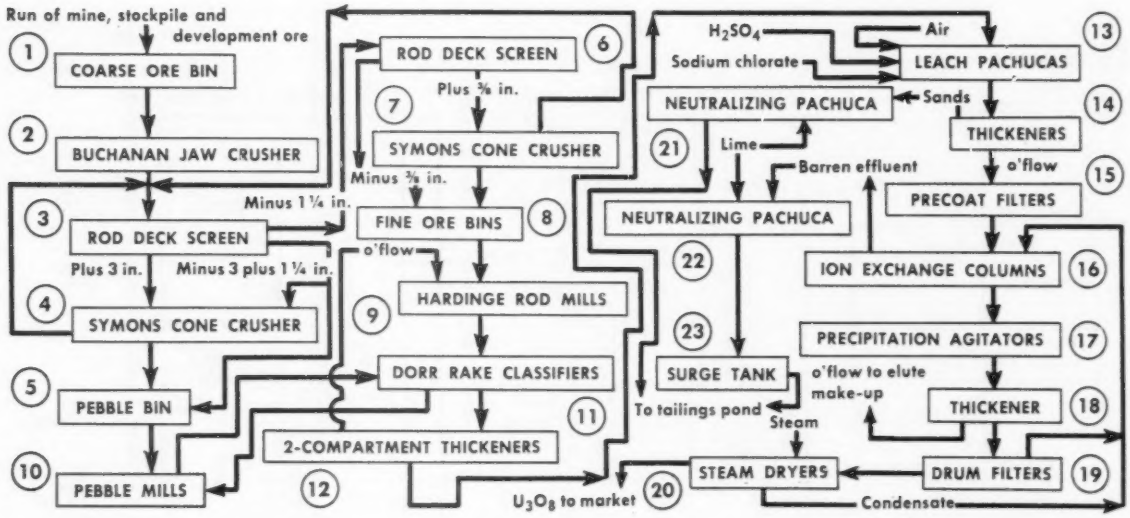
LEGEND

1. Concrete pit in which mine ore is dropped. High pressure water nozzle sluices feed into grizzly
2. Grizzly with 3-in. spacings
3. McLanahan & Stone 21x42-in. single roll toothed crusher (40hp)
4. Hewitt-Robins double deck 5x12-ft Vibrex screen (7.5hp), ⅛ in. openings
5. McLanahan & Stone 3x30-ft primary log washer; 3-in. slope, 28 rpm, 60hp
6. Hewitt-Robins 4x10-ft single deck Vibrex screen (7.5hp)
7. Pioneer 40x24-in. double roll crusher
8. Hewitt-Robins 3x6-ft single deck Vibrex screen (2hp)
9. McLanahan & Stone 18x18-in. double roll crusher (25hp)
10. McLanahan & Stone secondary log washer; 3x30-ft, 2.5-in. slope, 60hp
11. Hewitt-Robins 4x16-ft double deck Elliptex screen (15hp)
12. Western Machinery heavy media cone, 7-ft dia, (15hp)
13. 14. Divided Allis-Chalmers Lo-Head drain and wash screen, 3x16-ft, single deck, 5hp
15. Western Machinery Co. media hopper with adjustable diverting plate
16. Western Machinery wash hopper with adjustable diverting plate
17. Western Machinery 4-in. media pump (25hp)
18. Western Machinery 2-in. wash hopper pump (7.5hp)
19. Dings drum type 30x24-in. electromagnetic separator (1.5hp)
20. Western Machinery 2x17-ft Wemco densifier (1.5hp)
21. Demagnetizing coil (4-in.)

Results—Wemco Portable Mill uses a rounded ferrosilicon produced by Knapsack-Greisheim, Germany. Ferrosilicon loss is only ¾ lb per ton of cone separator feed. Reject or float from the cone assays 30 to 40% Mn, and is stockpiled for future market possibilities. General Services specification (40 to 48% Mn) manganese concentrate is produced at rate of 130 tph. Payroll shows 15 men.—Source *E&MJ*, May 1958.

Problem— How to mine and mill at least 1,000 tpd of Bancroft, Ontario, uranium-bearing pegmatite. Ore contains the usual pegmatite minerals —uraninite, uranothorite, fluorite, titanite, cyrtolite, calcite, pyrite, pyrrhotite and molybdenite. Bicroft Uranium Mines Ltd. developed the following solution.

Solution—



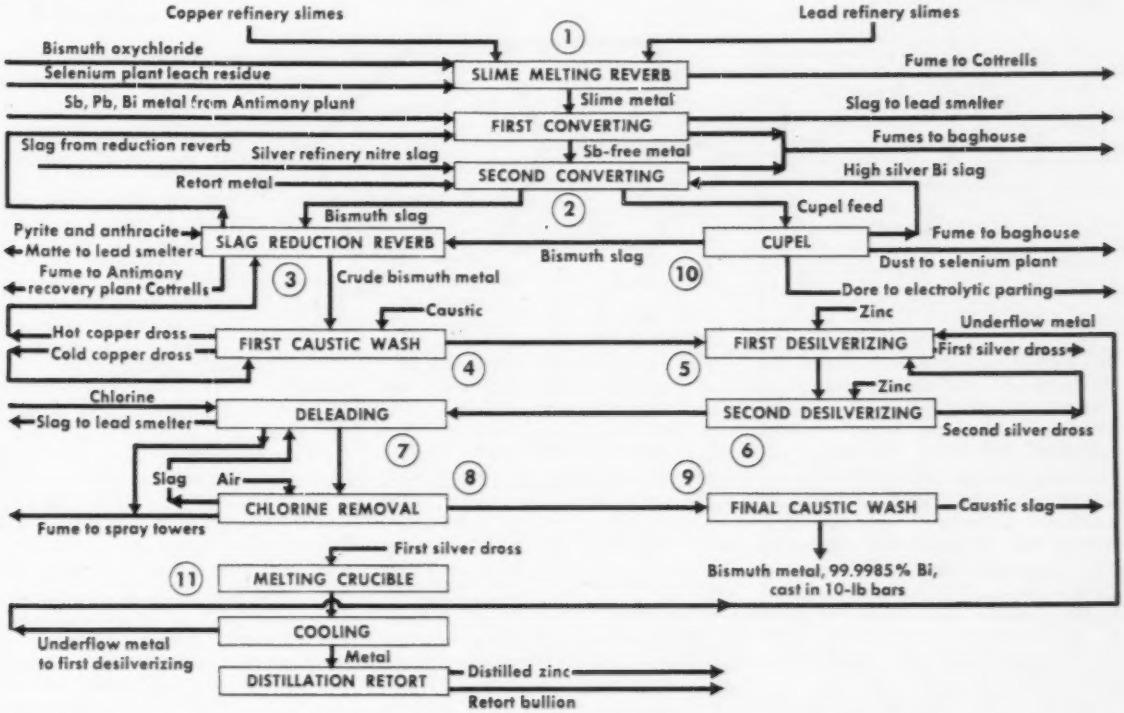
LEGEND

1. Run of mine, development and stockpile ore is stored in 1,000-ton coarse ore bin, steel with round bottom
2. Ore is broken in three stages. First at 3 in. in a 36x48 in. Birdsboro Buchanan jaw crusher discharging to Rod Deck screens
3. Two Symons 4x8 ft rod deck screens. Plus 3 in. goes to Symons Standard cone crusher. Minus 3 plus 1¼ in. goes to pebble bin. Minus 1¼ in. goes to No. 6 below
4. Symons, 4¼ ft Standard cone crusher breaks plus 3 in. feed and sends it back to Rod Deck (No. 3). Excess of pebble size is also broken here
5. Pebble bin holds 200 tons, sufficient for one shift's operation. Bin is wood stave with concrete bottom
6. Two Symons 4x8 ft Rod Deck screens send minus ⅜ in. to fine ore bins, and oversize to Symons Short Head
7. Symons 4 ft Short Head cone crusher set to break to minus ⅜ in. Capacity in this three-stage crushing house is 175 tph. Crusher dust is controlled by a Sly Dynaclone rated at 20,000 cfm
8. Fine ore bins—two 1,500 tons each, wood stave with concrete bottom. Twin cyclones and exhaust rated at 8,000 cfm on top
9. Two Hardinge 6x8 ft rod mills, each tied to a rake (No. 11 below). Each of these grinding circuits handles 650 tpd, grinding to 51% minus 200 mesh with less than 5% plus 65 mesh. 3-in. rods
10. Two 9x11 ft Hardinge pebble mills with grate discharge. Pebbles added automatically. Maximum-demand watt meter helps operator maintain peak grinding performance
11. Two 5x26 ft Dorr double rake classifiers. Overflow is pumped to No. 12 in a 5x5 in. SRL-V vertical sump pump
12. Two 40-ft double compartment Dorr thickeners. Overflow goes back to the grinding circuit. Pulp goes to leach tanks at 62% solids
13. Two lines of four pachucas each, 18x45 ft, conical bottom, wood stave, in series. Air is at 45 psi. After acid addition to each pachuca, the pH is 1.7 to 2.1. Acid consumption is 75 to 95 lb/ton. Sodium chlorate (1.5 to 1.8 lb/ton) is added to second pachuca
14. Two lines of five thickeners each, 60x12 ft, Dorr Type AA. Weak acid and wash water added (160 gpm) to fifth unit. Countercurrent flow. Uranium is 95% soluble
15. Two 8x16 ft Eimco Precoat drum filters, 55% submergence. Dressing is 2½ in. coat of diatomaceous earth on an open-weave polyethylene cloth. One coat lasts from 50 to 96 hours. Versene is used to complex colloidal iron which would blind the cloth. Flow rate through the filters is 390 gpm
16. Two lines of four fixed-bed ion exchange columns (Permutit Co.), each 8x14 ft, rubber-lined steel, 215 cubic ft of Amberlite IRA-400 resin in each tank. Three columns in series extract uranium while the fourth is on elute. When first of three is loaded, the pregnant solution feeds to second column, and the eluted fourth becomes the third (or scavenger column). Special circuit has been installed to combat fluoride contamination of the resin. Ion exchange recovery of uranium is 99.7%
17. Six precipitation agitator tanks, each 11x12 ft, wood stave. Precipitant is Aluminum Co. of Canada MgO-90, and is ground and slaked in a 30x54 in. Marcy ball mill. Precipitation pH is 7.0 to 7.5. Reagent feeder is a Dengler-Scott slurry feeder
18. Thickener, 20 ft dia, to collect and dewater precipitate. Wood stave with Dorr mechanism. Underflow is 25% solids on clear overflow. Flocculants added
19. Four 6x6 ft Eimco drum filters, steel and rubber-covered wooden deck
20. Two 18 ft dia Bartlett & Snow steam dryers. Feed is cake at 50% solids. Batches of cake, 1,500 to 2,000 lb each, are dried to less than 5% moisture in 6 to 8 hours. Dried product is discharged and elevated to a cyclone separator by a Hoffman vacuum pump. Product grade is 70% U_3O_8
21. Pachuca to neutralize mill effluent and tailings. Tank is 12x33 ft. Final pH is 8.0. Retention time is 75 minutes with 40 lb of high-grade quicklime added per ton of mill feed
22. Pachuca same as above
23. Surge tank, 18x20 ft, air-agitated to feed tailings line. Two 8x6 in. SRL-C pumps in series elevate the pulp 98 ft in 3,000 ft of 10-in. wood stave pipe to the tailings dam

Results— Final product is 70% U_3O_8. Reagent consumption in lb/ton is: grinding rods, 0.78; sulphuric acid, 99.8; sodium chlorate, 1.73; quicklime, 40.2; rock salt, 3.52; magnesia, 1.57; filter aid, 1.15; Separan, 0.14; and glue, 0.14. Average operating costs in 1957, based on an average 1,119 tpd mining and milling is estimated at—development $2.97, mining $3.72, milling $3.86, and general $1.06.—Source AIME 1958.

Problem—To refine bismuth from lead and copper smelter slimes at La Oroya, Peru. Cerro de Pasco Corp. developed this flowsheet.—Source W. C. Smith and P. J. Hickey, AIME annual meeting, 1958.

Solution—



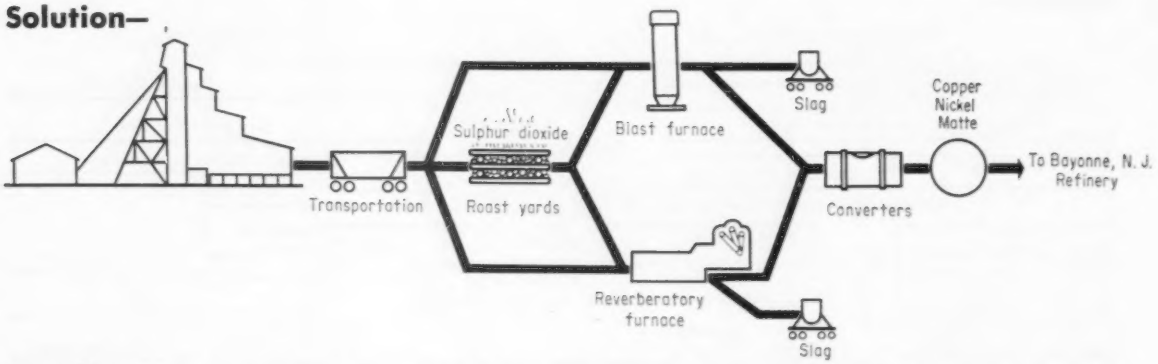
Results—

1. Slimes are blended, and fed by a water-cooled screw conveyor through the burner wall into the reverbs at a feed rate of 700 kilos per hour for six to seven hours; then one half to one hour is allowed for melting down. Operating temperature is 750 to 900 deg C with very little slag produced. Dust is refined in the antimony plant. Two slime melting reverbs, each 15 ft 2 in. by 7½ ft by 5 ft 10 in. outside, with 12 in. magnesite brick and 12 in. firebrick arch
2. Slime metal goes to any one of four converters, being tapped from the reverb into 800-kilo ladles for transfer by crane. Converters are 5½ ft by 13 ft 1 in., lined with 9 in. magnesite around the circumference and 12 in. magnesite on end walls. Five ½ in. dia tuyeres. Two Claridge fans of 15,000 cfm capacity. Off gases pass through hoods, U-tube coolers. Dust and fume is collected in two 8-compartment Dracco baghouses. Dust goes to antimony plant. Feed to converters assays about 5,702 oz Ag, 20 oz Au, 2% Cu, 21% Pb, 23% Sb, 1.5% As and 30% Bi. Two-step oxidation followed by skimming. First blow removes most of the arsenic and two thirds of the antimony at 900 to 1,000 deg C. Length of second blow is determined by slag and metal structure

   Second blow is at 1100 to 1200 deg C until silver content of the metal is 50 to 55%. Slag, running 20 to 40% of original bismuth charge, goes to reduction reverbs below
3. Two reduction reverberatory furnaces of same design as No. 1 above except that the hearth is level. Off gases go through Cottrell system (No. 1 above). About 2,500 kilos of converter slag (No. 3 above) and 2,500 kilos of cold cupel slag (No. 10 below) are added and heated to 1,000 to 1,100 deg C for eight hours. Anthracite (15% by weight) is added over the next six to eight hours with rabbling of the charge. Two or three tons of copper dross are added along with 21% by weight of pyrite and 1% anthracite. About four hours later a matte is tapped, the heat being turned off. Crude bismuth metal is tapped at 750 deg C into five 900-kilo pots and moved into the first refining kettle (No. 4 below). Crude metal assays about 1,050 oz Ag, 73% Bi and minor amounts of Cu, Pb, Sb and As
4. **5, 6, 7, 8** and **9.** Six 5-ton refining kettles, heated by oil-fired, low-pressure burners. No. 4, 5 and 6 are welded steel, and No. 7, 8 and 9 are cast iron to resist chlorine. No. 7 and 8 are hooded and exhausted
4. Refining begins here where copper, antimony, arsenic, tellurium, selenium and sulphur are removed as a hot dross at 500 deg C, then as a cold dross. Caustic and air blow used on each drossing step
5. First Parkes Process desilverization with zinc added after reheating. Two kilograms of zinc per kilogram of contained silver. Cooling yields Au-dross
6. Second desilverization step with 12.5 kilograms of zinc added per ton in kettle. Cooling yields Au-dross
7. Removing zinc and lead by dry chlorine addition at 550 deg C. One lb Cl_2 removes three lb of Pb. Step takes 18 to 24 hours
8. Chlorine and bismuth oxychloride removal at 500 deg C with air blow for 24 hours
9. Removing last traces of chlorine and metallic impurities with caustic slagging and air agitation at 450 deg C for six to eight hours. Pure 4-nine bismuth is hand cast into 10-lb bars
10. Metal from second converter step is added to one or the other of two tilting cupels for refining into Dore bullion. Off gases are passed by U-tube to two Dracco 4-compartment baghouses each with a 10,000 cfm Claridge fan. Charge is surface blown and slagged for a clean bismuth oxide slag (to No. 3 above), a Ag-Bi slag (to second converter), a soda ash-nitre slag (to selenium and tellurium recovery) and a final nitre slag for recycle into next cupel charge. Dore bullion is cast as 994 fine Ag-Au and sent to electrolytic parting
11. An oil-fired crucible, a retort and a small jaw crusher with screen, treat all intermediate kettle drosses and slags.

Problem—To smelt and refine copper-nickel-cobalt ores and concentrates mined in the Sudbury, Ontario, district. International Nickel Co. started in 1918 with this simple solution, then, as their technology expanded, grew into the complex smelter structure shown below as methods to extract other metals arose.

Solution—



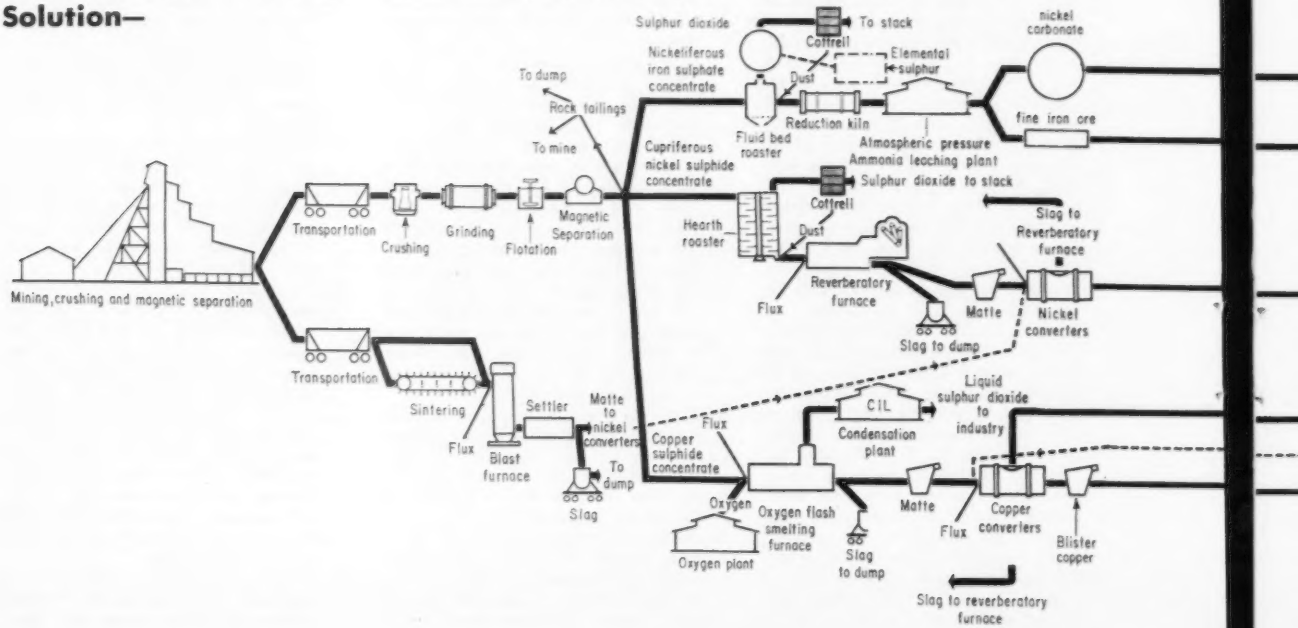
Results—International Nickel Co. produces 14 refined metals from Sudbury deposits—65% of the Free World's nickel, plus copper, cobalt, platinum, palladium, rhodium, ruthenium, iridium, gold, silver, iron, tellurium, selenium and the metalloid sulphur. Company operates five mines, two concentrators (more on the way), two smelters, an iron recovery plant, and a copper refinery in the Sudbury area. Also, they have a nickel-cobalt refinery at Port Colborne, and a nickel refinery (Carbonyl Process) at Clydach.

By late 1960 International Nickel Co.'s new $175-million, Thompson-Moak Lake, two-mine project in northern Manitoba is expected to build up to an annual production capacity of 75-million lb of nickel. This was revealed to some one hundred members of provincial and national government, and the Canadian and U. S. press on Oct. 20 at an "Operations Last Spike" ceremony marking completion of the 30-mile Canadian National rail spur which will serve the operation. Production from this new project will increase Inco's total annual nickel-producing capacity to 385-million lb by 1961.

Inco undertook extensive geologic reconnaissance of the area in 1946 because of favorable previous showings at Herb Lake and elsewhere. Aerial support in the form of airborne magnetometers and electromagnetic instruments hastened the delineation of favorable zones which were later probed by more than 1-million ft of diamond drilling costing some $6.75-million through August 1957. Up until Jan. 1, 1957, it cost Inco about $10-million to explore and develop the area.

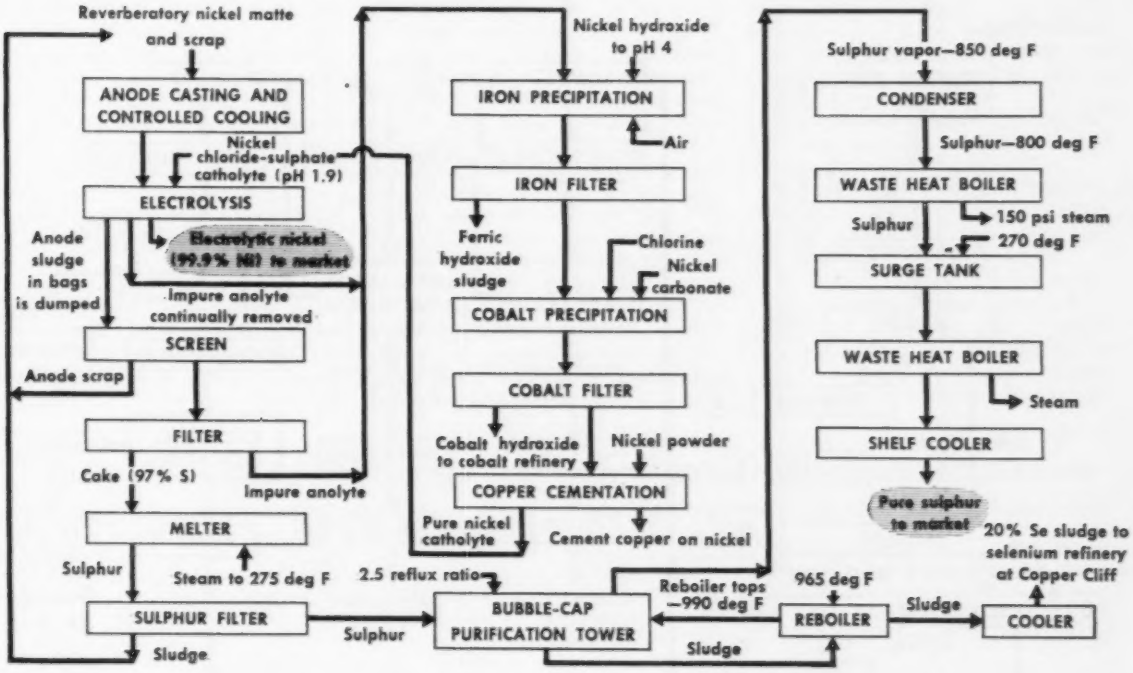
Inco's holdings at Thompson-Moak Lake comprise some 6,000 claims in a 10x80-mile area of about 300,000 acres. These holdings are leased from the Manitoba government on a 21-year agreement, with provisions for two additional 21-year extensions. Two mines are under development: The Thompson mine at the new railhead served by a development shaft and a production shaft some 2900 ft away; and the Moak Lake mine which will be connected with the Thompson site by a company-owned 22-mile railroad.—Source *E&MJ*, January 1957; and International Nickel Co. publications.

Solution—

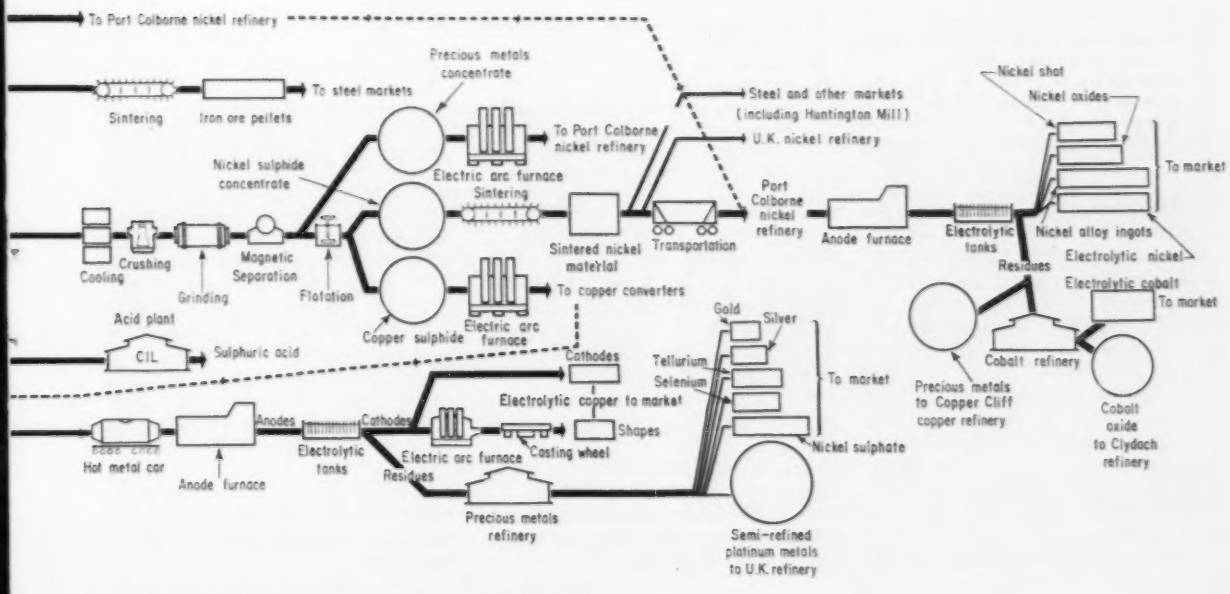


Problem—To produce electrolytic nickel using nickel matte as starting anode rather than conventional nickel metal anode. International Nickel Co. developed this process. Nickel sulphide of low copper content from the converter or any other source is cast into anodes under controlled conditions, then electrolyzed to metal.

Solution—

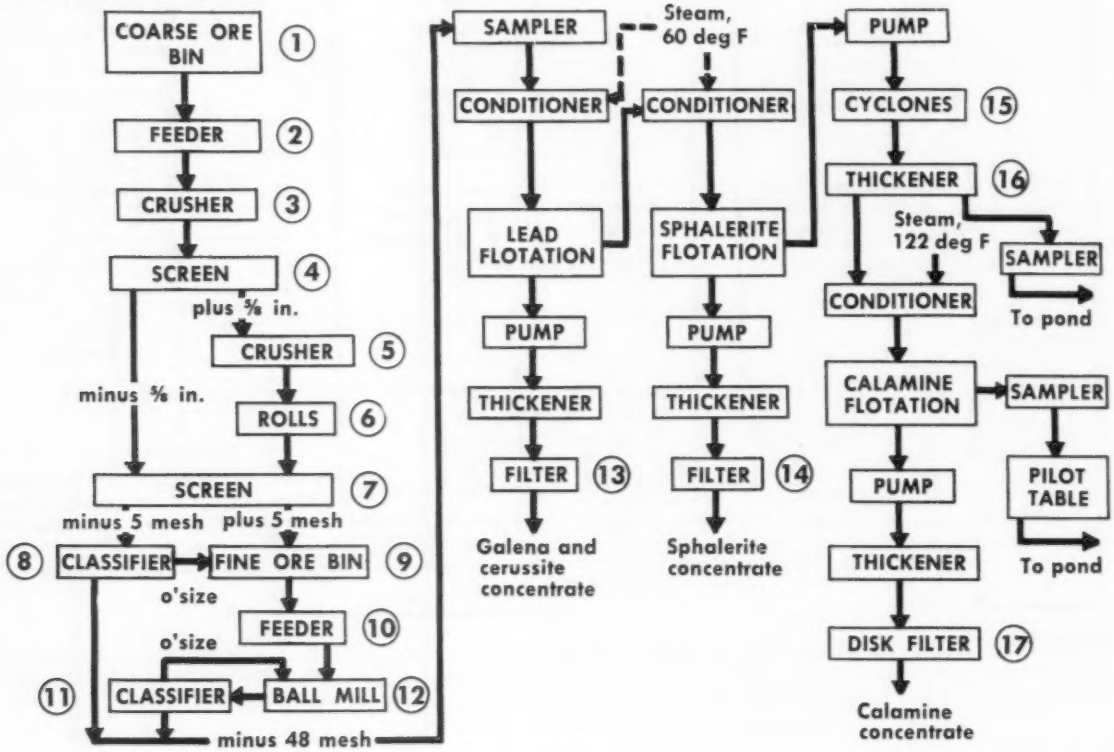


Results— High-grade nickel, pure elemental sulphur and selenium are recovered, in addition to cobalt, and precious metals. Process eliminates the ion exchange steps between matte and metal, and reduces metal losses.—Source International Nickel Co. release, March 1958; also see paper presented at AIME 1958.



Problem—To concentrate and recover zinc minerals from an 8% Zn ore that contained 25% of the zinc as oxidized minerals. Azienda Minerali Metallci Italiani, one of the world's oldest nonferrous metal producers, developed the calamine flotation flowsheet shown below to treat ore found at Gorno, Italy. Gorno's new mine began operation in 1952, but the mine located near Nossa, Bergamo Province, has been active since early Roman Empire days. Ore occurs in dolomite with chief minerals—sphalerite, calamine, cerussite and galena. Special reagents were developed by the Gorno staff.

Solution—



LEGEND

1. Two 400-ton coarse ore bins
2. Reciprocating feeder, 1 3/16-in. screen
3. Primary jaw crusher, 14x20-in.
4. Vibrating screen, 2½x6½-ft, ⅝-in. open
5. Secondary jaw crusher, 3x24-in.
6. Roll crusher, 36x18-in., ⅝-in. discharge
7. Vibrating screen, 4x10-ft, 5/16-in. open
8. MacLeon classifier sends minus 48 mesh to sampler
9. Fine ore bin, 700 ton
10. Belt feeder, 20-in.x30-ft
11. Dorr rake classifier, 6x21-ft, cuts at 48 mesh
12. Breda conical ball mill, 8x4-ft, 22 rpm, 200 hp
13. Disk filter, 4-ft 2-in.
14. Disk filter, 5-ft 5-in.
15. Cyclones, No. 4, 5½x32-in.
16. Overflow from cyclones goes to Dorr rake
17. Disk filter, 8½-ft 3-in.

Results— Gorno recovers three concentrates. Lead sulphide-oxide concentrate assays 60% Pb and recovery is 79.5%. Sphalerite concentrate assays 58.6% ZnS on an 89.24% recovery. Calamine concentrate assays 38.3% ZnO with a 76.4% recovery.

Tailings from the sphalerite section are sent to a set of No. 4 5½x32-in. cyclones through a 4-in Wilfley pump with a feed pressure of 28 psi. These recently installed cyclones successfully separate slimes harmful to the calamine circuit.

Cycloning has overcome abrupt changes in the ore and lowered reagent consumption—in particular that of copper sulphate stepped down from 5.3 to 2.936 lb. Efficiency of this apparatus is shown in screen-analysis back in Table II. The cyclones overflow at 200 mesh, but most of the pulp is minus 10 microns—97% minus. Also, underflow averages 61% plus 200 mesh and joins Dorr underflow.

Several materials of construction have been tested to withstand the wear of the apex valves, among which are: glass, bonded ceramic, soft rubber and titanium-steel alloy. The last one has proved to be by far the most satisfactory material for handling the kind of slurry fed to the cyclones on the calamine circuit.

Cyclone overflow gravitates to a 21-ft Dorr thickener whose overflow is sent to waste after automatic sampling and discharge volume measuring. In this instance, the classifier is overflowed at 200 mesh, and shows average 50% plus and minus 200 mesh, as indicated in the flowsheet above.

Concentrates are smelted at Nossa where a new electrolytic zinc plant has been erected.—Source *E&MJ*, April 1957.

Selecting Loaders for Mining

MUCKHANDLING EQUIPMENT being used and being introduced to mining is of such a wide variety that it is difficult to consider all of them and to select one for a particular job.

Classification is the first step. One approach could be based on the two basic handling functions: acquiring a load and moving it. Most of those that acquire a load also move it somewhere else (excavating or loading). Those that have a primary function of moving a load could be further divided according to whether they are designed for short distances (gathering) or for longer distances (transporting) and whether essentially horizontal (hauling) or vertical (hoisting). Alternative classification schemes based on power used, type of mount and innumerable other characteristics of the actual unit can also be used. And, of course the many combinations add to the complications.

In an attempt to systematize selection and establish some starting point, last year *E&MJ* prepared a list of standard classifications (see tables below) and a table of basic specifications (see page 99) with some examples. Shaft muckers were covered in detail although data for complete tabulation was lacking.

This year we have concentrated on one group called loaders. Some of these are illustrated on this and the following page. For the specification table on page 100, all known U.S. manufacturers were asked for data on their smallest, medium and largest size unit of each type. All replies are shown. Data on similar loaders that were presented last year have been repeated unless revised by the manufacturer. Certain specific entries appear to be incorrect and all should be carefully examined because only a minimum of editing has been done and that only when correct entry was known without question.

Most of the specifications can be taken from data sheets available from most manufacturers. These are simple physical measurements such as headroom, reach, bucket capacity, etc. The small variations in terminology have been eliminated by precise definitions.

Other data, such as "Output," are normally only available from manufacturers' representatives because they "depend on conditions." But by establishing standard conditions, comparable figures can be tabulated.

The table should certainly simplify preliminary selection at least. And it can be enlarged or amended to suit the user's more detailed needs.

In addition to selection of muckhandling units, the table may aid in planning. For instance, size of openings and number and size of production teams might be designed to permit easy conversion to other schemes.

E&MJ's Classification of Loaders

Scoop—[mount crowds]
- Front end lift
  - Hinged arms†
  - Rollers or slide*
- Overdump
  - Rocker arms†
  - Hinged arms*
  - Rollers* or slide

Dipper—[arm crowds]
- Fold arm
  - Standard†
  - Backhoe*
- Straightline
  - Standard†
  - Backhoe†

Slusher-ramp†

*—photo in 1956 or
†—1958 Guidebook

Self-loading conveyor
- Overdump bucket with drag-chain
  - Tilt bucket† belt
  - Eccentric arms† pan
  - Lugged chain shaker
  - Cleated disc bucket
  - Paddle wheel screw
  - Screw or auger chain
- Shaker
- Plow
- Slusher
- Bucketwheel
- Bucketline

Self-loading transport
- Scoop w/ slusher or belt if so
- Overdump bucket† w/slusher*
- Tilt apron† or bucket
- Slusher ramp*
- Scraper, wheeled

List of Other Muckhandling Equipment

Dredges, floating: bucketline, dipper shovel, dragline crane, grab crane, suction

Excavators: backhoe shovel, bucketline, bucketwheel, dipper shovel (shortboom, highlift), dragline crane, grab crane, hydraulic monitors, skimmer shovel, tower dragline scraper (moving or stationary)

Loaders: (also see other list), special shaft mucking, special tunnel mucking

Dozers: bull or angle, straight or U blade

Scrapers, dragline: hoists (two or three drum); buckets

Conveyors: stationary, mobile or movable; belt, bucket, or trolley, drag-chain, pneumatic, screw, shaking, vibrating

Railroad: cars or locomotives

Trucks or truck-tractors, full-trailers, semi-trailers

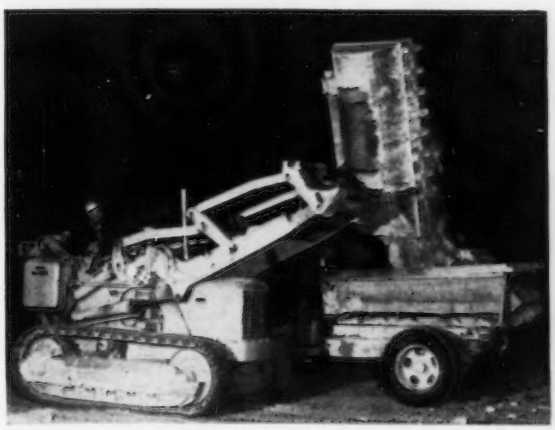
Skips: hoists (drum or friction); skips

Cableways or cable aerial tramways

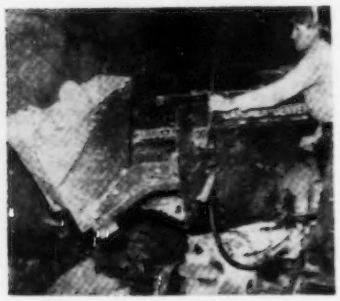
Pumps

Cranes: bridge or gantry

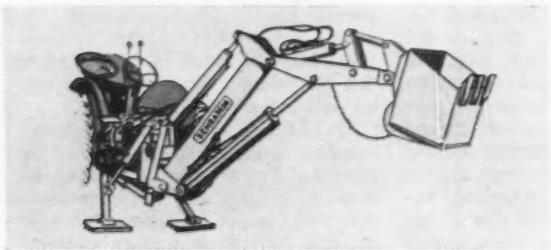
Monorail transporters: trolley or ground



RECENT EXAMPLES of loaders: scoop, front end lift (Caterpillar); dipper, straightline backhoe (Warner & Swasey)

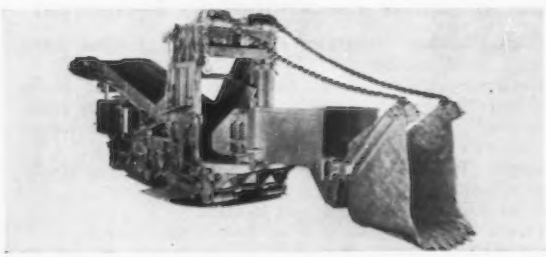


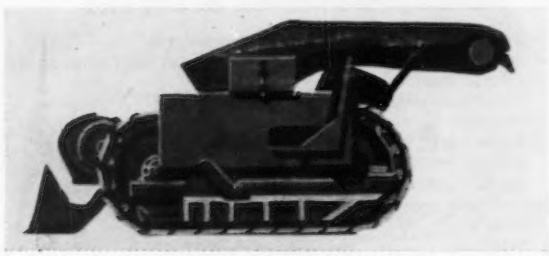
Scoop Loaders: front end lift, hinged arm, crawler (Case), wheeled (Hough); overdump, rocker arms, rail (Gardner-Denver)



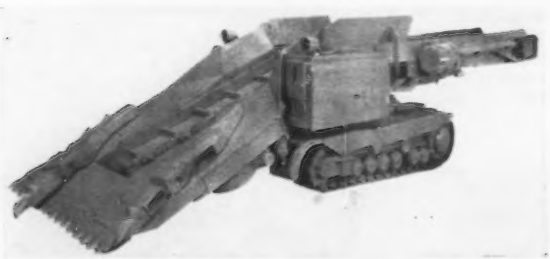
Dipper Loader, fold arm, standard (Schramm)

Dipper Loader, straightline, standard (Lorain)



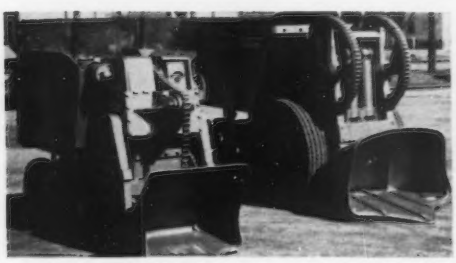
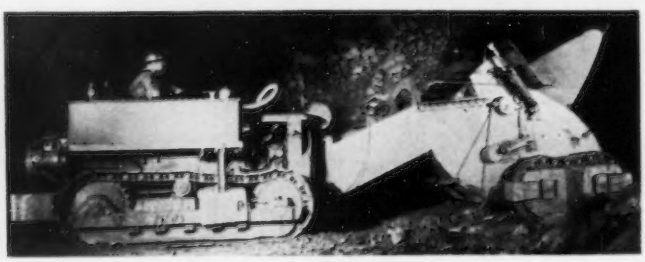


Self-loading conveyor loaders: tilt bucket with belt, rail (Goodman); and overdump (rocker) bucket with belt, crawler (Eimco)



Self-loading conveyor, eccentric arms with drag-chain (Joy)

Slusher-ramp loader, three drum axial, wheeled (Rogers)

Self-loading transports: overdump (hinged and rocker) bucket (Atlas Copco); and tilt apron (Sanford Day)

Key to Entries in—
E&MJ's Muckhandling Equipment Specification Table

(Use: dash if not applicable, "na" if not available, "x" if omitted, decimal fractions, letters shown in bold face for abbreviations)

1. a. Classification of unit – see suggested list.

b. Model – manufacturer's designation.

c. Manufacturer – abbreviated name.

2. Mount – **Crawler, Wheeled, Railroad, Skid, Walking Shoes, Floating, Foundation, Overhead Rail Trolley, Cableway**; plus, if applicable, **Self-Propelled, Pushed, Towed.**

3. Power – main operating engines(s) or motor(s).

a. HP – total installed net output at fly wheel or equivalent shaft at rated (governed) RPM at sea level at 60 deg F.

b. Type – **Air, Diesel, Diesel-electric, Electric battery, Electric cable, Electric trolley, Gas** combustion, **Gasoline, Hydraulic, Steam.**

4. Capacity

a. Volume (in cu yd)—On level, struck volume of container, approximate volume moved by blade-type component or approx. carrying volume per foot of conveyor length (see 5a below). For blades, show formula used to calculate in "Special Remarks" (line 17) or use 0.8 WH^2. For conveyors, show formula or use 0.03 W^2. (Note: W and H in yd).

b. Weight (in tons)—Maximum lift, carry, push or pull under optimum actual working conditions, through full function of machine but not necessarily through entire working range. Bucket or other container is considered part of machine. Note: It applies to the muckhandling function of machine, not the pull of a tractive type component (such as the tractor of a tractor shovel) unless the muckhandling function is based on this (such as bulldozer or slusher hoist). For self-propelled vehicles, maximum working drawbar-pull is usually considered as limited to 90% of total weight for crawler units and to 65% of weight on tread of driving wheels of wheeled units.

5. a. Productive Output (in tons per hr)—An approximate estimate under average practical working conditions with standard rated container entered in 4a with haul as indicated in 5b. Assume no waiting (idle) time, delays or maintenance or repairs. Based on handling average blasted rock or gravel, defined as having lumps up to about 18-in. cubes and weighing about 1.3 tons per cu yd in loose condition (Rock of Sp gr 2.6 with 40% voids). If equipment can only handle finer material add "F" after entry.

b. At Transport Distance (in ft)—Approximate practical (or recommended) transport distance, one way (i. e., load to dump), and indicate recommended maximum-minimum range in parentheses.

6. a. Initial Cost (in $) – Approximate new, f.o.b. manufacturer's plant, as described on line 8 a.

b. Additional per 100 ft haul (in $)—As described on line 8 b.

7. a. Operating Cost ($ per ton per 100 ft haul)—Rough estimate for U. S. not including depreciation or amortization, when handling material as indicated in 5 a above. For loading type equipment, ignore 100 ft haul specification. Include labor, power (or fuel), maintenance and repairs.

b. Operating Crew (number of men)—direct operating and helpers if needed.

8. a. Working Wt. Empty (in tons)—Complete empty unit (shipping weight less packaging). Including all essential components except that portion which may be varied in length to fit haul (does not include any railroad trackage).

b. Additional per 100 ft haul (in tons)—Approximate weight of additional components for extending haul 100 ft assuming minimum height of supports, straight level haul on firm smooth surface (including railroad trackage, trolley wire, etc.).

9. a. Working Clearances, Minimum H/W/L (in ft)—Smallest over-all space required for complete function of machine, i. e., all operations through loading, carrying and dumping, at ground or other most advantageous level (also see line 11). Assuming 90° swing or equivalent for loaders, except those which are especially designed for rear or side dump. For trucks, assuming no backup and turn while loading or dumping (also see line 14). For conveyors and slushers, covers only muck moving component. Does not include separate dumping mechanisms for railroads, certain trailers, etc., nor driving mechanisms of slushers, conveyors, etc. (see line 9b). H=height, L=Length in direction of axis of travel and W=width.

b. Auxiliary Clearance, Minimum WxHxL (in ft)— Over-all space required for essential separate driving or dumping mechanisms such as slusher hoist, rotary or other car or other vehicle dumping mechanisms.

10. Working Ranges—Under actual practical working conditions with standard equipment. Note: If any entry is based on longer or larger component than used for 9a, add "L" after entry.

a. Loading

(1) Size Opening WxH or L (in ft)—Clear inlet opening of container or dimension of blade or width of belt as given in 4a.

(2) Forward Reach, Max./Min. (in ft)—Distance of cutting edge or teeth of loader (at most advantageous elevation of container) while lifting rated quantity (see line 4a), measured horizontally along longitudinal centerline of operating unit from the nearest part of driving unit or mount. Assume no movement of mount itself. For dragline or clamshell crane this includes a bucket throw equal to 1/3 maximum bucket height.

(3) Side Reach, max./min. (in ft)—Distance of outside cutting edge at maximum possible angle or swing to side, measured horizontally at right angles from longitudinal centerline of operating unit.

(4) Depth Reach, max./min. (in ft)—Distance of cutting edge of loader below elevation of plane of contact between mount and support (i.e., ground level in most cases).

(5) Height (in ft)—For loaders maximum reach of cutting edge above plane in 10a (4). For transporters, height of lip or edge of muck carrying component above plane in 10a (4).

(6) Power Applied by – **Rope** (or cable), **Piston** (**Air, Hydraulic, Electric**), **Gears, Cam, Belt, Direct Connected, Mechanical Trip** (if gravity operated), **Separate Device.**

b. Dumping

(1) Size Opening WxHxL (in ft)—Clear outlet.

(2) Horizontal Reach, max./min. (in ft)—Distance of dumping lip from same point as in 10a (2), assume no casting effect.

(3) Height, max. (in ft)—Distance of dumping lip in highest dumping position from same plane as in 10a (4).

(4) Angle of Discharge (in deg)—Inclination of bottom surface of container in highest (full) dump position.

(5) Direction of Discharge—**Bottom, Side, Front** or **Rear.**

(6) Type of Discharge—**Tilt** slide, **Drop, Ejector Blade** or Conveyor.

(7) Power Applied by – as in 10a (6).

11. Traveling Clearances WxHxL (in ft)—For mobile units, completely assembled unit in working condition as in 9a but with containers, booms, etc., placed in most compact position without disassembly. L indicates length along axis of travel. For conveyors, dragline scraper-slushers and similar units, this entry only covers the overall dimensions of the driving mechanism or largest single component (not including erectable structural members) for moving purposes.

12. Traveling Speed: Empty, For./Rev. (in ft per min); **Loaded, For./Rev.** (in ft per min)—Maximum on level. Load is rated volume in 4a above. For conveyors, slushers and similar units, this entry covers working speeds of belt or rope, etc. For excavator-loaders it covers moving speed. Note: 10 mph = 880 ft per min.

13. Grade Negotiable, max., Loaded/Empty (in %)—Load is rated volume (4a above) of material indicated in 5a. For mobile units, climbing a hard, dry surface.

14. Turning Radius, min. (in ft)—Of outside edge. Equipment in normal position while moving forward with full rated load as indicated in 4a above. If any wheel, crawler, etc., must be fully braked or held idle to accomplish this, add "B" after entry. Do not show data which might be accomplished by reversing any part of running gear unless so designed, and if so, mark "R".

15. Ground Pressure, Empty/Loaded (in lb per sq in.)—Standard shoe and equipment. Load is rated volume in 4 a. of material indicated in 5a.

16. a. Moving Size Largest Component WxHxL (in ft)—largest single component into which unit can be disassembled by operating company mechanic for moving or shipping

b. Moving Weight Largest Component (in tons)—as above.

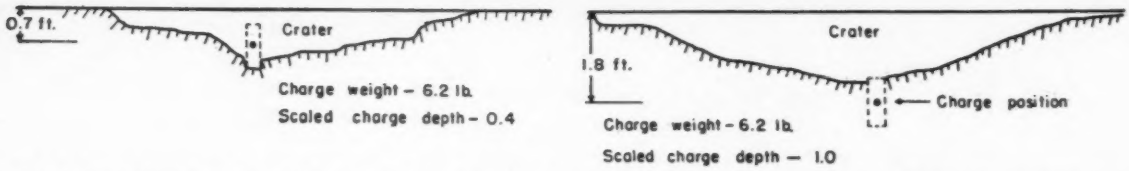
17. Special Remarks—Any outstanding main engine, power train or other mechanical specifications, special controls, any limitations or especially advantageous applications, any auxiliary attachments available, etc. Note: only limited space available.

1a Classification of unit	Loader Scoop Front end lift	Loader Scoop Front end lift	Loader Scoop Front end lift	Loader Scoop Front end lift	Loader Scoop Front end lift	Loader Scoop Front end lift	Loader Scoop Front end lift	Loader Scoop Front end lift	Loader Scoop Front end lift
b Model	HD-21	HD-16	HD-6	1000 RH	600 B	320 B	#977 Traxcavator Caterpillar	#955 Traxcavator Caterpillar	#933 Traxcavator Caterpillar
c Manufacturer	Allis-Chalmers	Allis-Chalmers	Allis-Chalmers	Case	Case	Case	Caterpillar	Caterpillar	Caterpillar
2 Mount	Cr S-P	Cr S-P	Cr S-P	Cr S-P	Cr S-P	Cr S-P	Cr S-P	Cr S-P	Cr S-P
3a Power: HP	225	150	72	90	56	38	100	70	50
b Type	D	D	D	D	D	G	D	D	D
4a Capacity: Vol. (in cu yd)	4.0	3.0	1.5	2	1	0.625	2.25	1.5	1
b Wt (in tons)	×	×	5.6	×	×	×	7.6	4	3.2
5a Productive output (in tons per hr)	400	350	185	×	×	×	262	195	130
b At transport distance (in ft)	75	75	75	×	×	×	15 (200-15)	15 (200-15)	15 (200-15)
6a Initial cost (in $)	×	×	×	16,650.25	10,444.15	5,380.15	24,325	16,530	11,940
b Additional per 100 ft haul (in $)	—	—	—	—	—	—	—	—	—
7a Operating cost ($ per ton per 100 ft)	×	×	×	×	×	×	×	×	×
b Operating crew (number of men)	1	1	1	1	1	1	1	1	1
8a Working wt. empty (in tons)	33.25	23.9	9.8	10.9	5.8	4.28	17.4	11.2	8.4
b Additional per 100 ft haul (in tons)	—	—	—	—	—	—	—	—	—
9a Working clearances, min. H/W/L (ft)	11.0/9.3/21.2	10.2/9.3/19.3	8.0/6.3/4.8	5.7/6.3/16.4	5.4/5.3/13.8	5.3/4.9/12.2	7.5/8/17	6.8/6.67/15.1	6.4/5.83/13.7
b Auxiliary clearance, min. WxHxL (ft)	—x—x—	—x—x—	—x—x—	—	—	—	—	—	—
10 Working data & ranges:									
a Loading:									
(1) Size opening W x H or L (in ft)	9.3 x 5.0	9.3 x 4.0	6.3 x 3.5	6.75 x ×	5.25 x ×	5.22 x ×	8.0 x ×	6.67 x ×	5.83 x ×
(2) Forward reach, max./min. (in ft)	×/—	×/—	×/—	×/—	×/—	×/—	×/—	×/—	×/—
(3) Side reach, max./min. (in ft)	×/0	×/0	×/0	×/0	×/0	×/0	×/0	×/0	×/0
(4) Depth reach, max./min. (in ft)	0.75/0	0.67/0	0.83/0	0.8/0	0.9/0	1.6/0	.83/0	1.0/0	.83/0
(5) Height (in ft)	11.8	12.3	10.0	×	×	×	12	10.67	9.9
(6) Power applied by	P (H)	P (H)	P (H)	P (H)	P (H)	P (H)	P (H)	P (H)	P (H
b Dumping:									
(1) Size opening W x H or L (in ft)	9.3 x 5.0	9.3 x 4.0	6.3 x 3.5	6.75 x ×	5.25 x ×	5.22 x ×	8 x ×	6.67 x ×	5.83 x ×
(2) Horizontal reach max./min. (in ft)	4.4/×	4.1/×	2.6/×	3.5/3.5	2.7/1.8	2.8/2.3	3.33/×	3.25/×	2.45/×
(3) Height, max. (in ft)	11.8	12.3	10.0	8.42	9.0	8.33	15.6	14.4	12.8
(4) Angle of discharge (in deg.)	50	59	49	45	45	45	50	50	50
(5) Direction of discharge	F	F	F	F	F	F	F	F	F
(6) Type	T	T	T	T	T	T	T	T	T
(7) Power applied by	P (H)	P (H)	P (H)	P (H)	P (H)	P (H)	P (H)	P (H)	P (H)
11 Traveling clearances W x H x L (in ft)	9.3 x 8.8 x 21.2	9.3 x 8.3 x 19.3	6.3 x 5.8 x 14.8	x x	5.4 x 5.3 x 14.5	5.3 x 4.9 x 13.0	7.5 x 8 x 17	6.8 x 6.67 x 15.1	6.4 x 5.83 x 13.7
12 Speed: Empty: for./rev. (fpm)	563/308	633/484	485/360	528/616	580.8/633.6	397.8/176.9	670/528	607/264	537/273
Loaded: for./rev. (fpm)	563/308	633/484	485/360	×/×	×/×	×/×	132/167	150/167	150/185
13 Max. grade, loaded/empty (in %)	100/×	100/×	100/×	×/×	×/×	×/×	na/na	na/na	na/na
14 Turning radius, min. (in ft)	×	×	10.4	7.33	8.67	6.25	na	na	na
15 Ground pressure, empty/loaded (psi)	11.7/14.2	10.3/12.6	9.1/11.4	8.6/11.0	6.4/7.5	7.2/8.8	9.2/11	9.2/11.2	9.4/11
16a Size largest component W x H x L (in ft)	× x × x ×	× x × x ×	× x × x ×	4.8 x 3.1 x 2.4	4.3 x 2.8 x 2.2	5.0 x 1.8 x 2.9	× x × x	× x × x	× x × x
b Wt. largest component (in tons)	×	×	×	1.0	0.75	0.275	×	×	×
17 Special remarks:				Rear hinged bucket. Complete tractor-loader combination unit.	Front hinged bucket	Front hinged bucket	Complete tractor-loader combination. Also have side dumping 1.63 cu yd bucket model 955 and a larger one for 977		

1a	Loader Scoop Front end lift	Loader Scoop Front end lift	Loader Scoop Front end lift	Loader Scoop Front end lift	Loader Scoop Front end lift	Loader Dipper Foldarm Backhoe	Loader Dipper Foldarm Standard	Loader Scoop Overdump Rocker arm	Loader Scoop Overdump Rocker arm	Loader Scoop Overdump Rocker arm	Loader Scoop Overdump Rocker arm
b	18K3 Skid shovel	Speedall 250	Speedall 175	Speedall 125	Pneumatractor Loader	Pneumatractor Backhoe	Pneumatractor Shovel-Bucket	105 OHL	630	12B	21
c	Int. Harvester	Pettibone	Pettibone	Pettibone	Schramm	Schramm	Schramm	Eimco	Eimco	Eimco	Eimco
2	Cr S-P	Wh S-P	Wh S-P	Wh S-P	Wh S-P	Wh S-P	Wh S-P	Cr S-P	Cr S-P	Rr S-P	Rr S-P
3a	105	147	124 ; 105	97 ; 77	41	41	41	143	36 (3 @ 12)	15 (2 @ 7.5)	24 (2 @ 12)
b	D	D	G ; D	G ; D	D ; G	D ; G	D or G	D	Ah ; E	Ah	Ah ; E
4a	3	2.5	1.75	1.25	1	0.2	0.26	1.5	0.22—0.45	0.17—0.22	0.28—0.37
b	×	5.25	3.75	2.75	1.25	1.0	1.25	6.0	2.0	0.9	1.02
5a	na	×	×	×	×	×	×	623	180	105	184
b	na	×	×	×	×	×	×	10	15	Nil (Remark)	Nil (Remark)
6a	25,778	22,500	17,400 ; 19,120	14,100 ; 15,265	8,000	9,800	9,900	25,400	9,800 (Air)	3,370	4,720 (Air)
b	—	—	—	—	—	—	—	—	—	—	—
7a	na	×	×	×	×	×	×	0.020	0.006	0.006	0.005
b	1	1	1	1	1	1	1	1	1	1	1
8a	20.8	12.7	10.1	×	4.5	4.25	4.5	20.0	5.0	2.25	3.6
b	—	—	—	—	—	—	—	—	—	—	—
9a	16.6/8.0/19.0	×/×/×	×/×/×	×/×/×	11.0/6.0/15.0	13/22/22	12/22/22	17.6/7.7/16.0	8.0/5.7/11.0	6.0/3.0/8.0	7.3/4.0/9.6
b	—	—	—	—	—	—	—	—	—	—	—
10											
a											
(1)	8.0 x ×	8.0 x ×	7.1 x ×	7.1 x ×	6.0 x 2.5	2.0 x 2.2	2.0 x 1.7	10.0 x 18.0	4.5 x 2.5	2.5 x 2.5	3.0 x 2.5
(2)	×/—	4.5/—	3.4/—	3.4/—	×/—	16/5	16/5	5.9/—	7.5/—	4.25/—	5.2/—
(3)	×/0	×/0	×/0	×/0	×/0	12/4	12/4	×/0	×/0	4.5/0	5.0/0
(4)	1.16/0	×/0	×/0	×/0	0.5/0	9.5/0	9.0/0	1.5/0	1.9/0.1	0.3/0.2	0.3/0.2
(5)	12.75	8.8	8.8	8.2	11.0	14.4	12.7	11.5	7.25	5.75	6.5
(6)	P (H)	P (H)	P (H)	P (H)	P (H)	P (H)	P (H)	R	R	R	R
b											
(1)	× x ×	8.0 x ×	7.1 x ×	7.1 x ×	6.0 x 2.5	2.0 x 2.2	2.0 x 1.7	8.0 x 8.0	4.5 x 2.5	2.5 x 2.0	3.0 x 2.5
(2)	×/×	4.5/	3.4/	3.7/	8.5/8.0	16/×	16/×	5.6/5.0	2.0/1.5	2.0/1.16	2.3/1.5
(3)	10.33	8.8	8.8	8.2	11.0	14.4	12.7	11.5	7.1	5.0	5.6
(4)	59	50	50	48	Vertical	Vertical	Vertical	Remark	Remark	Remark	Remark
(5)	F	F	F	F	F	B	B	R	R	R	R
(6)	T or D	T	T	T	T	T	D	T (cast)	T (cast)	T (cast)	T (cast)
(7)	P (H)	P (H)	P (H)	P (H)	P (H)	P (H)	P (H)	R	R	R	R
11	8.0 x 16.6 x 19.0	8.0 x 8.0 x 20.8	7.3 x 7.9 x 19.5	6.3 x 9.3 x 18.7	6 x 5 x 11	6 x 9 × 12	6 x 9 12	7.7 x 9.5 x 16.0	5.0 x 5.0 x 9.2	2.5 x 4.0 x 6.0	3.0 x 4.8 x 7.3
12	537/334	2,138/×	2,068/×	2,387/×	900/175	900/175	900/175	200/480	0/134	0/268	0/268
	537/334				900/175	900/175	900/175	200/480	0/134	0/268	0/268
13	×/×	53/×	50/×	42/×	×/×	×/×	×/×	70/100	×/70	×/100	×/100
14	8.0	26.8	23.6	22.5	12.8	12.8	12.8	7.0 R	3.9 R	Rail unit	Rail unit
15	12.1/×	×/×	×/×	×/×	16/19	15/16	15/16	12/×	12/×	Rail unit	Rail unit
16a	× x × x ×	× x × x ×			6 x 5 x 10	6 x 5 x 10	6 x 5 x 10	× x × x ×	× x × x ×	× x × x ×	× x × x ×
b	×	×			3	3	3	×	×	×	×
17					Has integral 125 cfm air compressor	Has integral 125 cfm air compressor. Bucketline trencher & auger attachment available		7a from limited reports. Buckets are custom made to suit working conditions		5b—Loader is coupled to car	

1a	Loader Scoop	Loader Scoop	Loader Scoop	Loader Scoop	Loader Scoop	Loader Scoop	Loader Scoop	Loader Scoop	Loader Scoop	Loader Scoop	Loader Scoop
b	Front end lift Michigan	Front end lift Michigan	Front end lift Michigan	Front end lift 105 FEL	Front end lift ! HA	Front end lift HH	Front end lift HO	Front end lift 12.	Front end lift LD-5PD	Front end lift LD-7AD	Front end lift LD-8AD
c	Clark	Clark	Clark	Eimco	Payloader Hough	Payloader Hough	Payloader Hough	Payloader Hough	Scoopmobile Mixermobile	Scoopmobile Mixermobile	Scoopmobile Mixermobile
2	Wh S-P	Wh S-P	Wh S-P	Cr S-P	Wh S-P	Wh S-P	Wh S-P	Cr S-P	Wh S-P	Wh S-P	Wh S-P
3a	80	120	133	143	38	96	122	91.5	87	130	160
b	D ; G	D ; G	D ;'G	D	D	D	D	D	D	D	D
4a	1.25	2.0	2.75	2.5	0.51	1.3	1.75	1.3	1.5	2.5	3.5
b	1.7	2.75	3.75	6.0	1 (carry)	3.5 (carry)	4.5 (carry)	2.5 (carry)	2.5	4.5	5.0
5a	245	330	390	1040	×	×	×	×	na	na	na
b	40	40	▼ 40	10	×	×	×	×	na	na	na
6a	13,300	17,500	21,000	26,500	5,855	18,500	20,750	16,500	14,650.00	20,500.00	28,500.00
b	—	—	—	—	—	—	—	—	—	—	—
7a	×	×	×	0.020	×	×	×	×	na	na	na
b	1	1	1	1	1	1	1	1	1	1	1
8a	6.7	8.8	12.8	22.0	2.6	8.2	12.0	10.4	6.25	10.0	14.0
b	—	—	—	—	—	—	—	—	—	—	—
9a	6.7/6.7/16.6	7.2/7.4/17.9	7.8/8.3/19.7	9.1/7.9/17.2	na/na/na	na/na/na	na	na	7.0×7.2×19.2	8.4×9.0×20.0	8.4×9.2×23.8
b	—	—	—	—	—	—	—	—	—	—	—
10											
a											
(1)	6.5 x 2.8	7.6 x 3.3	8.0 x 3.8	10.0 x 10.0	4.0 x ×	7.0 x ×	7.5 x ×	7.0 x ×	7.2 x ×	8.2 x ×	8.2 x ×
(2)	×/—	×/—	×/—	4.5/—	1.8/—	3.8/—	4.5/—	4.6/—	×/—	×/—	×/—
(3)	×/0	×/0	×/0	×/0	×/0	×/0	×/0	×/0	20 deg swing	20 deg swing	20 deg swing
(4)	×/0	×/0	×/0	1.2/0	×/0	1.0/0	×/0	×/0	1.7/0	1.5/0	1.7/0
(5)	8.0	8.2	8.5	14.5	5.2	9.0	10.0	8.8	9.0	10.0	10.0
(6)	P (H)	P (H)	P (H)	P (H)	P (H)	P (H)	P (H)	P (H)	P (H)	P (H)	P (H)
b											
(1)	6.5 x 2.8	7.6 x 3.3	8.0 x 3.8	8.0 x 8.0	4.0 x ×	7.0 x ×	7.5 x ×	7.0 x ×	7.2 x ×	8.2 x ×	8.2 x ×
(2)	×/×	×/×	×/×	4.5/—	1.8/—	3.8/—	4.5/—	4.6	3.1/1.1	3.7/1.3	4/2.5
(3)	8.0	8.2	8.5	11.5	5.2	9.0	10.0	8.8	9.0	10.0	10.0
(4)	55	55	55	50	40	55	50	50	45	45	45
(5)	F	F	F	F	F	F	F	F	F	F	F
(6)	T	T	T	T	T	T	T	T	T	T	T
(7)	P (H)	P (H)	P (H)	P (H)	P (H)	P (H)	P (H)	P (H)	P (H)	P (H)	P (H)
11	6.9 x 6.7 x 17.1	7.8 x 7.2 x 18.2	8.3 x 7.8 x 20.2	7.9 x 9.1 x 17.2	na x na x na	na x na x na	na	na	6.5 x 8.2 x 19.2	7.7 x 9.3 x 20.0	8.5 x 10.3 x 24.6
12	2290/2290	2110/2110	2110/2110	200/480	555/898	1,804/2,332	2,112/2,112	880/1,021	1,760/1,760	1,760/1,760	1,760/1,760
	2290/2290	2110/2110	2110/2110	200/480	×/×	×/×	×/×	×/×	1,280/1,280	1,280/1,280	1,280/1,280
13	50/60	50/60	50/60	70/100	17/17	17/17	17/17	17/17	×/×	×/×	×/×
14	17.4	9.3	21.1	7.0 R	6.3	19.4	22.6	11.2	20.5	24.7	25.5
15	20.8/26.6	30.3/60.0	31.6/63.0	12/×	×/×	×/×	×/×	×/×	×/×	×/×	×/×
16a	× x × ×	× x × ×	× x × ×	× x × ×	4.3 x 4.8 x 10	7.0 x 7.5 x 17.3	7.5 x 8.3 x 19	7 x 7.5 x 15.8	×	×	×
b	×	×	×	×	2.6	8.2	12.0	10.4	×	×	×
17	Four wheel drive, rear wheel steer; torque convertor, planetary axles, power shift transmission, 24v electrical system			7a from limited reports Bucket custom made	Also make a "HU" Model with 1 cu yd bucket				10b(2) is from front of tires at dumping height of 7 ft and at max. height, respectively		

1a	Loader Scoop	Loader Scoop	Loader Scoop	Loader Scoop	Loader rocker	Loader Eccentric	Loader Eccentric	Self-l'd tran.	Self-l'd tran.	L'd'g attach. Scoop	L'd'g attach Scoop
b	Overdump Rocker arm	Overdump Rocker arm	Overdump Rocker arm	Overdump Rocker arm	bucket w/belt	arms w/drag chain	arms w/drag chain	Overdump bucket (hinge arm) w/tilt box	Overdump bucket (rocker arm) w/tilt box	Front end lift (for tractor)	Front end lift (for tractor)
c	GD 9	GD 10	GD 15	JSL-7 Shovel Loader	40H	18-HR2 Gath. head ldr.	19-HR Gath. head ldr.	T2G	T4G	L-440IC	LL-D8 or TD24
2	Gardner-Denver Rr S-P	Gardner-Denver Rr S-P	Gardner-Denver Rr S-P	Joy Cr S-P	Eimco Rr S-P	Joy Cr S-P	Joy Cr S-P	Atlas Copco Wh S-P	Atlas Copco Wh S-P	Amer. Tractor (Cr)	Amer. Tractor (Cr)
3a	×	×	×	15	51 (total)	94 (total)	150 (total)	17	25.4	×	×
b	Ah	Ah	Ah	Ah or Ec	Ah ; E	Ec	Ec	Ah	Ah	×	×
4a	×	0.18	0.23	0.18—0.43	0.33—0.48	—	—	0.9 [0.16]	2.0 [0.35]	0.75	7.0
b	×	×	×	×	2.8	—	—	2	3.6	2.5	25
5a	20—30	×	×	120—130	320	175—200	225—275	30	50	na	na
b	Nil	Nil	Nil	×	Nil (Remark)	×	×	100 (to 300)	100 (to 300)	na	na
6a	×	×	×	×	14,430 (Air)	×	×	×	×	1.900	21,110
b	—	—	—	—	—	—	—	×	×	—	—
7a	×	×	×	×	0.010	×	×	×	×	na	na
b	1	1	1	1	1	1	1	1	1	1	1
8a	2.1	2.4	3.55	A-48; Ec-5.6	8.4	20	29	2	3.5	1.6	17
b	—	—	—	—	—	—	—	0.1	0.1	—	—
9a	6.3/2.7/7.6	6.1/2.9/7.2	7.4/4.2/8.0	6.5/5.75/9.3	7.5/6.0/21.0	7/6.5/×	8.5/6.5/×	7/7/10	9/9/14	×/×/×	×/×/×
b	—	—	—	—	—	—	—	—	—	—	—
10											
a											
(1)	× x ×	× x ×	3.5 x ×	× x ×	3.5 x 3.0	×	×	3 [×] x 4 [×]	4 [×] x 6 [×]	5.75 x ×	9.0 x ×
(2)	2.2/—	×/—	2.1/—	×/—	8.3/—	×/—	×/—	1.2/—	2.3/—	×/—	×/—
(3)	3.9/0	×/0	3.9/0	×/0	7.0/0	×/0	×/0	×/0	×/0	×/0	×/0
(4)	×/0	×/0	×/0	.75/0	0.75/0.4	.75/0	1.5/0	×/×	×/×	×/0	×/0
(5)	×	×	×	7.25—10.25	7.0	5	5.5	7	9	9.6	14.0
(6)	R	R	R	R	R	G	G	R	R	P (H)	P (H)
b											
(1)	× x ×	× x ×	3.5 x ×	× x ×	2.5 x —	×	×	3 x 2	4 x 2.5	× x ×	× x ×
(2)	1.3/×	1.1/×	1.3/×	×/×	10.0/7.0	13/×	×/×	×/×	×/×	2½/×	5.0/×
(3)	3.7	3.9	4.7	×	6.5	8	9.3	×	×	8.0	12.0
(4)	×	×	×	×	Vert. (Remk)	—	—	43	43	45	45
(5)	R	R	R	R	R	R (90° swing)	R (90° swing)	R	R	F	F
(6)	T (cast)	T (cast)	T (cast)	T (cast)	C	C	C	T	T	T	T
(7)	R	R	R	R	D	G	G	P (A)	P (A)	P (H)	P (H)
11	2.7 x 4.1×6.3	2.6 x 4.1 x 6.1	3.0 x 4.8 x 6.7	×	6.0 x 6.0 x 20.5	×	×	5 x 5 x 8	6 x 6 x 11	× x × x ×	× x × x ×
12	×/×	×/×	×/×	168.8/168.8	0/268	37-106/37-106	35-70/35-70	260/×	200/×	×/×	×/×
	×/×	×/×	×/×	×/×	0/268	×/×	×/×	260/×	200/×	×/×	×/×
13	×/×	×/×	×/×	16/×	×/20	×/40	×/40	12/×	12/×	×/×	×/×
14	Rail unit	Rail unit	Rail unit	×	Rail unit	×	×	8	18	×	×
15	Rail unit	Rail unit	Rail unit	.08/×	Rail unit	×/×	×/×	42/71	50/100	×/×	×/×
16a	× x × ×	× x × ×	× x × ×	× x × ×	× x × ×	×	×	3.5 x 2.5 x 6	4.5 x 3 x 8	× x × ×	×
b	×	×	×	×	×	×	×	1	2	×	×
17	9H&L have higher dump height. Also have models 14&14H similar to model 10	10H has higher dump		Has 6 ton draw bar pull	Coupled to car Buckets made to fit work			Loading bucket specifications given in brackets		For John Deere 440 IC	For Cat D8 or I-H TD24 Also have 4 yd



CROSS SECTIONS OF THREE CRATERS IN GRANITE show in sequence from left to right the effect of increased burden on a constant weight of explosive. The third drawing confirms one basic corollary of the reflection theory of blasting —that craters can be formed at a free surface with solid rock existing between crater zone and shotpoint. (USBM drawings)

Boning Up

BLASTING RESEARCH has advanced our knowledge of the science considerably in the last decade even though the results have not received very wide publicity. Probably the most important development is the conclusive proof of the reflection theory of failure under explosive loads. In addition, a number of empirical formulae have been developed that relate explosive and rock factors to each other.

This section of the Guidebook summarizes these advances and also gives some of the literature on the general subject of blasting. An outline of cost analysis in blasting is also presented plus some surface drilling and blasting case histories.

The Reflection Theory

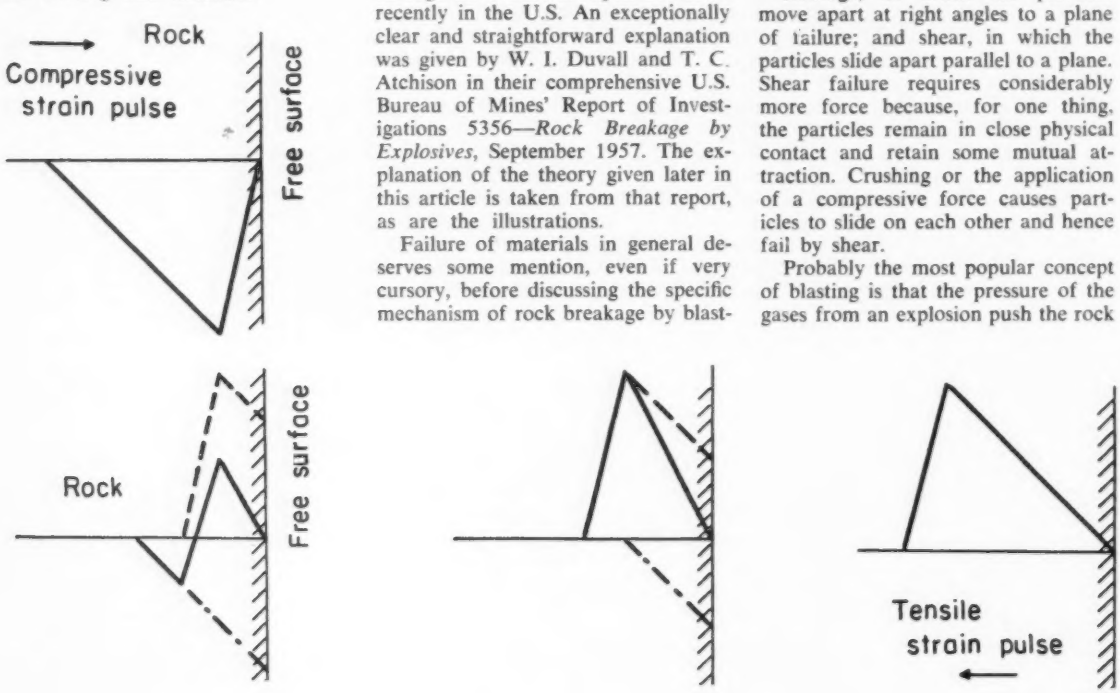
The reflection theory of blasting—also called scabbing or tension slabbing—has not yet become a widely known concept in spite of its age and great impact on the effective use of explosives.

During World War II, defense agencies conducted experiments on on the behavior of metals under impulsive loads and proved the basic concept. But it was not until the early 1950's that the concept received much attention in the literature. Apparently it was Kumao Hino who first showed and promoted its application to mining through his articles in Japan and more recently in the U.S. An exceptionally clear and straightforward explanation was given by W. I. Duvall and T. C. Atchison in their comprehensive U.S. Bureau of Mines' Report of Investigations 5356—*Rock Breakage by Explosives*, September 1957. The explanation of the theory given later in this article is taken from that report, as are the illustrations.

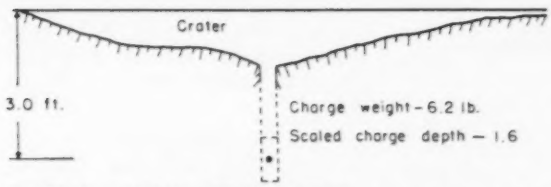
Failure of materials in general deserves some mention, even if very cursory, before discussing the specific mechanism of rock breakage by blasting. In one sense, mechanical failure of solids can be defined as a loss of resistance to an external force, ultimately leading to separation into two or more parts. Starting at the size of the atom and progressing on up to a polycrystalline material such as rock, failure results from an external force overcoming the force holding the particles together. The bonding force does not suddenly end but rather it becomes insufficient after the particles have been displaced (strained) a a certain distance. The material then begins cracking.

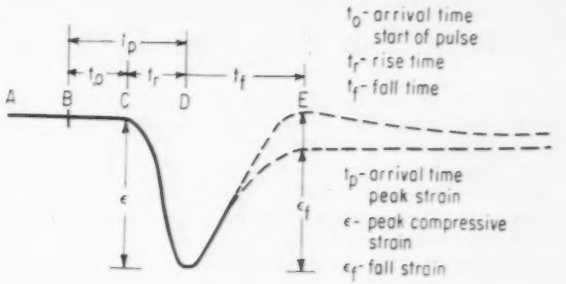
Essentially, all failure is in tension although achieved in one of two ways —cleavage, in which the particles move apart at right angles to a plane of failure; and shear, in which the particles slide apart parallel to a plane. Shear failure requires considerably more force because, for one thing, the particles remain in close physical contact and retain some mutual attraction. Crushing or the application of a compressive force causes particles to slide on each other and hence fail by shear.

Probably the most popular concept of blasting is that the pressure of the gases from an explosion push the rock



REFLECTION of plane triangular compressive strain pulse impinging normal to free surface is used to illustrate the way compression reflects as tension. Maximum tensile strain develops at distance from free face equal to half the fall length of the compressive pulse. Solid line is resultant of incident (uneven dashes) and reflected (even dashes) portions of pulse.





TYPICAL RADIAL STRAIN PULSE (far right) has steep front and more gradual decay. The expanding spherical compressive wave also produces a similar tangential tensile pulse.

On Blasting

outward from the blasthole toward a free surface and thereby shear the rock away from the solid along certain planes. However, evidence now shows that except for very small burdens —probably less than one foot—the expanding gases account for very little of the rock breakage.

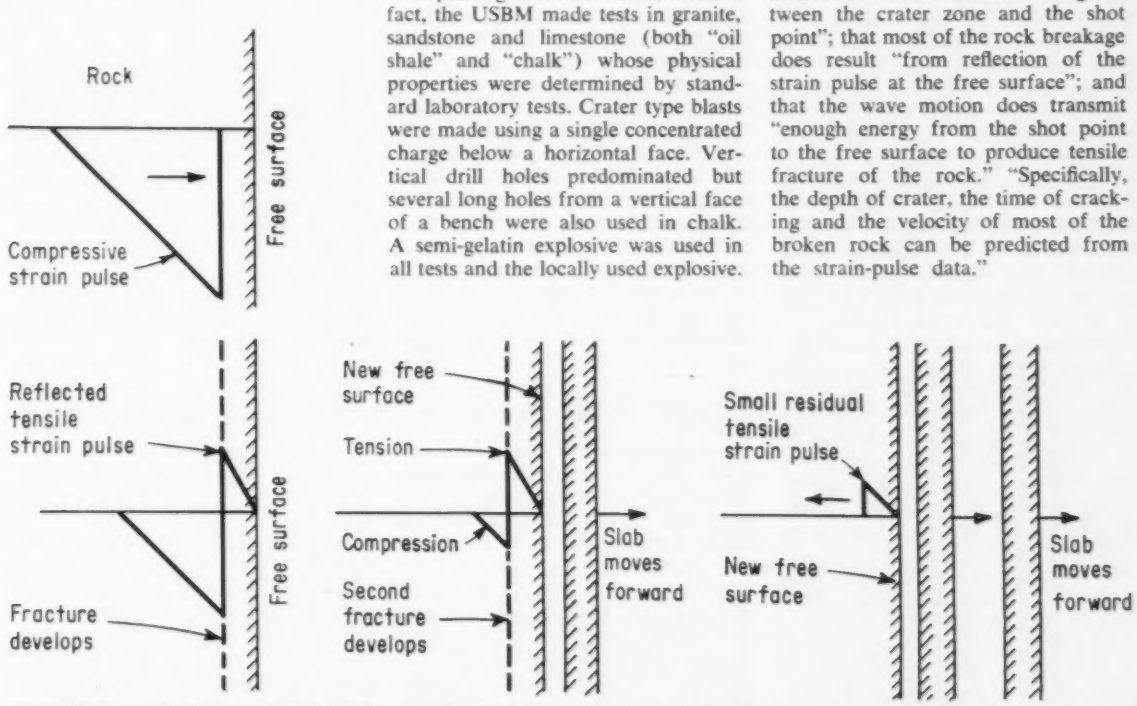
The general mechanism of rock breakage by explosives, as shown by ample evidence, is as follows:

"The detonation of the explosive charge creates a high gas pressure in the charge hole, which in turn generates a compressive strain pulse in the surrounding rock. This compressive strain pulse travels outward in all directions from the charge hole. Near the charge hole the amplitude of this strain pulse is sufficient to cause crushing of the rock. However, as the strain pulse travels outward its amplitude decays rapidly until no further crushing of the rock is possible. The compressive strain pulse continues to travel outward until it is reflected by a free surface. Upon reflection the compressive strain pulse becomes a tensile strain pulse. As the strength of rock in tension is much less than in compression, the reflected tensile strain pulse is able to break the rock in tension, progressing from the free surface back toward the shot point. In other words, the rock is pulled apart, not pushed apart."

In proving that this mechanism is a fact, the USBM made tests in granite, sandstone and limestone (both "oil shale" and "chalk") whose physical properties were determined by standard laboratory tests. Crater type blasts were made using a single concentrated charge below a horizontal face. Vertical drill holes predominated but several long holes from a vertical face of a bench were also used in chalk. A semi-gelatin explosive was used in all tests and the locally used explosive.

Strain gages, cemented in drill holes, were oriented to measure radial movement at various distances from the shot at the elevation of the shot. Strips of conducting foil, cemented to the face in concentric circles around the collar of the blastholes, were used to sense cracking of the face. Both measurements gave electrical responses that were recorded against time. In addition a 3,000 frame per second motion picture camera was used to determine velocity of muck movement and degree of fragmentation as well as to observe other phenomena.

The results show "that craters can be formed at a free surface without the presence of any gas in the crater zone and with solid rock existing between the crater zone and the shot point"; that most of the rock breakage does result "from reflection of the strain pulse at the free surface"; and that the wave motion does transmit "enough energy from the shot point to the free surface to produce tensile fracture of the rock." "Specifically, the depth of crater, the time of cracking and the velocity of most of the broken rock can be predicted from the strain-pulse data."



SCABBING results if the reflected tensile strain is more than the tensile strength of rock. The number of slabs is equal to the first whole number less than the ratio of fall strain to breaking strain. If ratio is over two, depth of crater is about half fall length but not more than the charge depth. Slabs move forward because of energy trapped inside. (from USBM)

Formulae Can Help Plan Efficient Blasts

CALCULATION of permissible burdens and the required amount of explosive for an efficient blast is still not a simple matter of inserting values in a standard, universal formula. But current research—especially on the reflection theory—appears to have tied the variables down rather closely and it may not be long before we do have such a formula. Nevertheless, at present there are several empirical guides that can aid planning.

A number of simple formulae have been based on the relationship that the quantity of explosive is directly proportional to the quantity of rock broken. Quantity is generally measured by weight, which is a function of volume, and volume, in turn, varies as the cube of a length. Thus the required weight, Q, of a single concentrated (i.e., crater) charge breaking to a plane surface will vary as the cube of the burden distance, B: $Q = KB^3$, where K is an experimentally determined numerical factor that takes care of variations in rock and explosive characteristics. For a column charge in a drill hole, the formulae could be $Q = KB^2$ per ft and, knowing the density of the explosive, the size of hole required could be calculated. With such formulae it has been found that K for soft, tough rock will be about twice the K for hard, brittle rock. Likewise, an increase in the number of faces to which the charge can break will reduce K; thus K for a cube (six faces) is only one-fourth the K for a bench blast (two faces).

Other formulae have been based on incorrect but useful assumptions. Some are based on assuming that the blast will shear at a constant angle with the face—usually 45 deg—and give an explosive factor of 0.5 to 1.0 lb per ton. One bench blasting formula assumes that the blast must overcome the tensile strength of rock over the new face area plus the shear strength of the rock over the new floor area plus the frictional resistance of the whole block moving across the new floor area. And there is a coyote tunnel blasting formula based simply on shearing the new floor area using 2 to 2½ lb per sq ft.

Probably the most direct formula is that of O. Anderson ("Blast Hole Burden Design", Proc. Australian IMM No. 166-167, Melbourne, 1952). It is based on, and conforms to, a great number of underground and surface practices in a wide variety of ground all over the world. It is a very simple formula: $B = \sqrt{dL}$, where B is burden in ft, d is dia blasthole in in. and L is length of hole in ft on single whole shots or when holes are at the recommended maximum spacing S=1.5B. If a smaller spacing, S_2, is used then the new burden

$$B_2 = \frac{-S_2 + \sqrt{S_2^2 + 4A}}{2}$$

where $A = B^2 + SB$. If free face is less than 2B then the new burden should also be used: $B_2 = \sqrt{Bx}$, where x is half the length of the free face. To improve fragmentation—which is adversely affected by deep holes, wide spacing and large burden—burden may be reduced to two-thirds of that calculated.

A markedly similar formula can be derived from one which is used to establish a rock characteristic called resistance to blasting by K. H. Frankel ("Factors Influencing Blasting Results", Manual on Rock Blasting Section 6:02, Stockholm, 1952). Solved for maximum burden it gives:

$$B = \frac{R\,L^{0.3}l^{0.3}d^{0.8}}{50}$$

where B is burden in meters, R is resistance to blasting (experimental factor, one for difficult-to-break to six for very-easily-broken rock with two being a rough mean of frequent figures), L is length of hole in meters, l is length of charge in meters and d is dia of hole in mm. It appears even more similar when the following "practical" values are used: reduce actual B to 0.8B and limit it to less than 2/3L; use l=0.75L; and keep spacing under 1.5B. Frankel says this has been used since 1944 with 35% LFB explosive, a common Swedish ammonia gelatin dynamite that is widely used in mining.

A burden formula based on physical characteristics of rock and explosive was offered by G. E. Pearse ("Rock Blasting" *Mine & Quarry Engineering*, London, January 1955). It is:

$$B = Kd\sqrt{\frac{P_s}{T}}$$

where B is critical radius (or maximum burden) in in., K is a constant based on rock characteristics and varies from 0.7 to 1.0 with an average of 0.8 (it can be calculated using Poisson's ratio and the damping characteristic of the rock), d is the cartridge dia (or hole dia with proper confinement by tamping and stemming) in inches, P_s is reaction stability pressure of explosive in psi and T is ultimate tensile strength of rock in psi.

Other formulae are worthy of review in a thorough study, but many become highly involved. One that has received some recognition was developed by U. Langefors ("The Calculation of Charges for Bench Blasting and Stoping", Manual on Rock Blasting Section 6:05, Stockholm, 1954).

Vibration produced by a blast has come in for considerable study and a simple formula for planning purposes has been suggested by R. Westwater ("Heading Blasting", *Mine & Quarry Engineering*, London, July 1957). It is:

$$A = \frac{K\sqrt{Q}}{D}$$

where A is amplitude of vibration in 0.001 in., K is a ground factor varying from 100 in hard rock to 300 in wet rock or clay, Q is lb of explosive and D is distance between blast and point of interest in ft. He mentions that amplitudes of 0.008 in. will not damage normal structures but that it should be kept below 0.003 to prevent human sensing and complaints. Other studies have emphasized the critical effect of acceleration rather than just amplitude.

Some Good Sources Of Blasting Knowledge

BIBLIOGRAPHIES that may help the reader in more comprehensive study of blasting are given in the sources mentioned in the text above and in these four university publications:

UNIVERSITY PUBLICATIONS

Symposium on Rock Mechanics, Colorado School of Mines Quarterly Vol. 51 No. 3, Golden, Colo., July 1956, $2.00—includes several papers on the latest basic concepts of blasting.

Symposium on Mining Research, Bulletin 95 (1958) and Bulletin 94 (1957), University of Missouri School of Mines, Rolla, Mo.—both include papers on basic concepts and some applications; Bulletin 95 also covers use of ammonium nitrate.

Drilling & Blasting Symposium, University of Minnesota, Minneapolis, Minn., 1956, fee—includes papers on theory as well as on practice.

MANUFACTURERS' RELEASES

American Cyanamid Co.:—Case History Brochures on Quarrying, Coal Stripping and Construction (1957)—see p. 110; Electric Blasting Caps (15 pp, 1957)—includes sections on circuits, patterns and accessories.

Atlas Powder Co.:—Blasting Cost Chart and Manuals (1958)—see next page.

Canadian Industries Ltd.:—Explosives & Blasting Accessories Catalog (48 pp, 1957)—includes a chart of applications and recommended explosive.

Commercial Solvent Corp.:—Data Sheet on Use of Ammonium Nitrate and 2-NP (1958).

DuPont de Nemours & Co.:—Blasters' Handbook (516 pp, 1958, $1.75)—the latest comprehensive text on practical methods of using explosives.

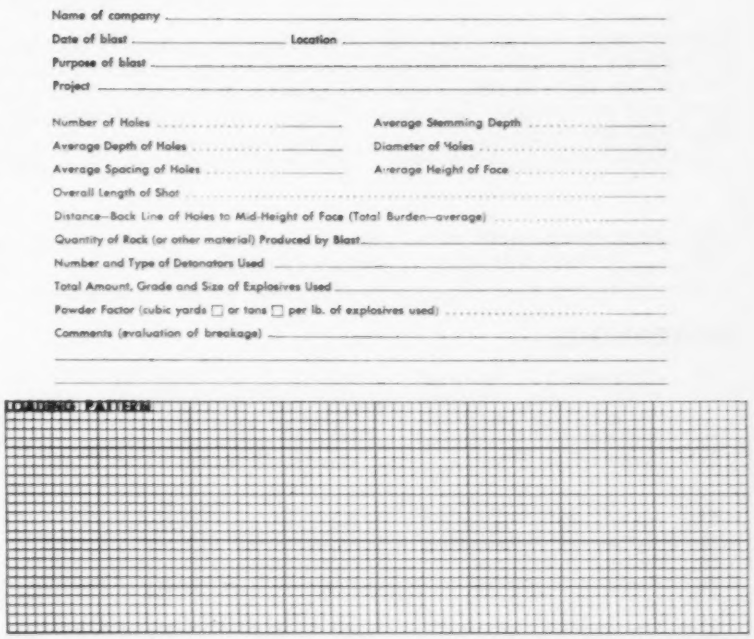
Ensign-Bickford Co.:—Efficient Blasting with Safety Fuse (35 pp, 1958)—a very complete discussion of proper use of safety fuse; Detonating Fuse (20 pp, 1957)—a similar manual on Primacord; Ignitacord and Quarrycord booklets—brief texts on their use.

Hercules Powder Co.:—Blasting Vibration: Cause and Effect (26 min sound-color movie, 1958)—an interesting explanation aimed at general public.

Chart Your Breaking Cost to Get the Full Picture

BLASTING EFFICIENCY cannot be viewed in isolation from the processes which precede and follow it, i.e., drilling, handling and crushing. The real measure of efficiency is cost per unit of final product and not necessarily the unit cost of any single step. For example, inexpensive explosives may require larger blastholes for proper detonation. On the other hand, excessive explosive force may scatter the muckpile and make handling more costly. Poor fragmentation, whether from too few holes, too weak explosive or other reasons, may make handling and crushing more expensive. Recording data on your entire rock breaking and handling process is the starting point for improving blasting efficiency.

A simple, easy-to-use method of recording rock breaking data is currently being promoted by Atlas Powder Co. The company has prepared, and made freely available to users of explosives, a printed form on which all data can be entered with a minimum of bookkeeping. Although primarily designed to be used for a single blast, it can be used for any type of operation on surface or underground with minor changes. Two supplementary booklets—"How to Use the Atlas Blasting Cost Chart," and "Blasting Cost Control Manual"—aid the user. The manual gives many helpful details for computing the entries, among which is a handy table of "Average Useful Life of Equipment" (abstracted from Internal Revenue Bulletin F) for proper accounting of equipment costs.


Name of company
Date of blast
Location
Purpose of blast
Project
Number of Holes
Average Stemming Depth
Average Depth of Holes
Diameter of Holes
Average Spacing of Holes
Average Height of Face
Overall Length of Shot
Distance—Back Line of Holes to Mid-Height of Face (Total Burden—average)
Quantity of Rock (or other material) Produced by Blast
Number and Type of Detonators Used
Total Amount, Grade and Size of Explosives Used
Powder Factor (cubic yards ☐ or tons ☐ per lb. of explosives used)
Comments (evaluation of breakage)
LOADING PATTERN

COVER OF FILE FOLDER serves as form for entering all physical data on a blast. Inside covers are printed with outline of cost analysis breakdown and brief reminders of items to be included. On back is a check list for cutting costs. (Atlas Powder Co.)

Atlas Blasting Cost Chart

The chart is actually a conventional file folder. Printed on the cover are blank items to be used for basic physical data (see illustration). Printed on the inside is a blank outline for cost analysis.

The cost analysis outline is divided into four operations:

Drilling
Primary Blasting
Secondary Breakage
Digging, Hauling and Crushing.

In addition, there is a "Miscellaneous" category to accommodate costs that cannot be assigned to one of the above phases.

Each of the four operations is subdivided into three cost classifications:

Operating
Materials and Supplies
Maintenance and Repairs

These costs are entered as actual dollars and are totaled separately for each of the four operations. The dollar cost of each of the four operations is then divided by the quantity (tons or cubic yd) of material produced to get a unit of comparison.

Details on the way of treating each of these costs is covered in the manual. Briefly, some of the major points are:

Operating costs are of two types—direct and indirect. Direct operating costs include labor and supervision, and power or fuel. The major indirect cost is for capital equipment, i.e., rent or depreciation.

Materials and supplies are items which are expended or consumed in the operation. Drill bits and blasting caps are examples.

Maintenance and repair costs usually include two major items. The first is labor, and the second includes parts and supplies. It is probably best to pro-rate maintenance and repair costs from experience over a period of time since, in most cases, it will be impossible to assign specific repairs to specific blasts.

Other costs may be difficult to assign to a particular shot, too. However, if the total of these costs is known, they can be pro-rated. To simplify the use of the Atlas chart, involved costs might even be neglected, not because they are insignificant, but because they may be considered to affect each cost computation equally. If this is done, it should be remembered that the resulting blasting cost will not be the true cost but only a relative figure. Such figures will be useful only for comparing blasts whose costs have been determined in the same way.

Putting the Chart to Work

In discussing putting the completed cost chart to work, the manual says: The first chart completed will normally have information value only, although it may arouse speculation on ways of improving efficiency. Of course, if any cost items appear out of line, remedies should be effected.

The true value of the chart will become evident after it has been used several times. Then it will provide positive evidence of the effectiveness of operating changes. But, the manual concludes, control your experiments by trying to change only one factor at a time so that results can be attributed to the proper factor and not hopelessly hidden.

Compare Your Drilling and Blasting

CASE HISTORIES are useful not only for comparing the efficiency but also because they stimulate critical analysis of your own practice. They may also suggest new methods.

The tables below are taken almost verbatim from a series of brochures prepared by (and available from) the Explosives department of American Cyanamid Co. Three brochures have been prepared: Quarrying, Stripping (Coal) and Construction. The examples given here are only about half of the total presented in the brochures. Some data given in the original presentation have been changed slightly as stated in the footnotes. Some original data have also been omitted; for

Line No.	Formation & stratification (numbers indicate ft)		Shovel & output (cu yd) (cu yd/hr)	Crusher size (in.)	Drill type & speed (ft/hr)		Bit type & life (ft/sharp X sharps)	
QUARRYING								
1	Limestone	horizontal	1½	30 x 32	MW Rotary	20		3000x
3	Shale	horizontal	1½	18 x 24	Wagon	15		60x
5	Shale	horizontal	¾	14 x 28	Wagon	25		30x
7	Limestone	horizontal	1½	24 x 38	Wagon	10		20x
11	Limestone	solid	1½	20 x 36	Churn	8		120x
12	Dolomite	massive horiz.	2	50 x 50 Imp.	Churn	9		300x
13	Limestone	massive	2½	NO. 10	HW Rotary	45		3700x
19	Granite	massive	2	36 x 42	T-500	20	Carbide	25x
20	Slate	thin	1½	36 Cone	Churn	10		50x
21	Trap	solid	2	40 x 48	T-500	20	Carbide	20x
22	Limestone	folded	2½	36 x 60 Roll	Air Trac	30	Carbide	500x
26	Granite	folded	1½	30 x 42	Wagon	30		24x
27	Granite	decomposed	¾	18 x 36	Air Trac	35		300x
29	Limestone	1–3 horizontal	1½	36 x 48	Wagon	60		500x
32	Limestone	3–5 horizontal	1½	32 x 40 Imp.	Air Trac	60		75x
33	Limestone	3–5 horizontal	1½	36 x 48	Wagon	80		75x
34	Limestone	3–5 horizontal	5	48 Gyra	IR-X71	50		50x
37	Limestone	3–5 horizontal	5	48 Gyra	Wagon	55	Carbide	3000x
40	Limestone	solid	¾	24 x 30	Wagon	30		150x
43	Silica L'Stone	thin horizontal	¾	24 x 32	LW Rotary	12		200x
45	Dolomite	blocky	1½	48 x 60	Qmaster	20	Carbide	4000x
46	Sandstone	seamy	1½	40 x 40 Imp.	Wagon	36		92x
47	Granite	blocky	2½	30 x 42	Churn	3.5		9x
48	Dolomite	solid	1½	32 x 40 Imp.	Wagon	40		1000x
49	Limestone	45 deg pitch	hand.	18 x 36	Churn	3		200x
52	Limestone	massive	4 & 5	48 x 60	HW Rotary	30		3700x
53	Granite	medium	2	30 x 36	T-500	15	Carbide	45x
56	Trap	heavy	4	48 Gyra	Qmaster	8	Carbide	1000x
57	Trap	folded	4	48 Gyra	Down Hole Qm	12	Carbide	800x
60	Dolomite	folded	2	36 x 48	MW Rotary	25		1000x
62	Limestone	massive	¾	30 x 42	Churn	5		11x
64	Mica Schist	folded	1½	40 x 40 Imp.	HW Rotary	35		1500x
67	Dolomite	blocky	1½	43 x 50 Imp.	HW Rotary	25		1000x
78	Dolomite	vertical	2½	50 x 50 Imp.	HW Rotary	15		850x
80	Sandstone	folded	5	—	50-R Rotary	70		4000x
82	Limestone	massive	1½	25 x 36	Churn	5		6x
85	Limestone	45 deg pitch	2¾	24 x 36	MW Rotary	15		1000x
91	Limestone	45 deg pitch	1½	24 x 36	LW Rotary	10		200x
92	Limestone	45 deg pitch	1½	25 Gyra	Churn	3		300x
94	Granite	thick horizontal	2½–5	42 Gyra	Jet Piercing	16		—

NOTES: Data omits mention of any chambering.

For Quarrying, original data gave "Face height" to which "Sub drill" footage has been added to give "Hole depth".

For stripping, "Formation" column shows thickness of formations from top to bottom: C-clay; Cl-coal; G-glacial drift; L-limestone; S-shale; Sl-slate; Ss-sandstone. In "Shovel size" column, D-dragline. In "Hole depth" column, H-horizontal holes. Original data gave "Bit size", now retitled "Hole dia".

with This Summary of Current Practice

instance, the original construction case histories showed blasting patterns and power source used for detonation.

Shovel and crusher size data is of interest because of its relationship to fragmentation that must be produced. Shovel production data is interesting because of possible effects that finer fragmentation may have on increasing output rate; tempered, of course, by the efficiency of scheduling haulage equipment. And, although drill and bit data have no direct relationship to blasting, they are part of the rock breaking process.

Similar tables were prepared by *E&MJ* for Guidebooks in May 1954 (p G8) and Mid-March 1955 (p 50).

Hole dia (in.)	Hole depth (ft)	Sub drill (ft)	Spacing (ft)	Burden (ft)	Explosive & method of detonation*		Explosive ratio**	Line No.
6¼	47½	2½	20	14	40% & 50% Ammonia	T	3.5 t/lb	1
3	25	5	8	10	Semigelatinous	B	5.3	3
2¾	23	3	5	10	Semigelatinous	B	3.25	5
3	38	3	5½	5	60% Gelatin	B	3.6	7
6½	29	4	16	14	40% Gelatin 65% Ammonia	T	2.5	11
7	39	4	22	15	Blasting Agent LV	B	3.0	12
7⅞	25	5	19	15	Blasting Agent LV	B	2.7	13
4	32	2	11	12	75% Gelatin 60% Ammonia	B	2.77	19
8	48	3	25	30	75% & 60% Gelatin 60% Ammonia	B	3.0	20
4	30	2	12	11	75% & 60% Gelatin 60% Ammonia	B	3.3	21
3½	46	4	12	14	60% Gelatin—Semigelatinous	B	4.3	22
2½	24	2	5	5	60% Gelatin	B	2.3	26
3	45	5	8	8	60% Gelatin	B	1.5	27
2½	24	0	6	6	Semigelatinous	M	3.5	29
1¾	20	0	6	4	60% Ammonia	T	2.2	32
1¾	23	0	8	4	Semigelatinous	T	3.5	33
1¾	20	0	8	4	60% Ammonia	T	3.4	34
2⅜	22	0	11	5	65% Extra & Semigelatinous	T	3.6	37
2¼	21	1	5	5	60% Gelatin—50% Ammonia	M	2.5	40
6	33	3	15	16	60% Gelatin	B	2.4	43
6¼	32	2	16	16	Semigelatinous	T	3.0	45
3	17	2	6	6	60% & 40% Gelatin	B	2.3	46
6	46	6	18	20	Blasting Agent HV	T	3.3	47
2	20	0	6	6	60% Ammonia	B	4.1	48
5⅜	73	5	15	25	60% Gelatin—50% Ammonia	T	3.0	49
7⅞	88	8	25	12	Blasting Agent LV	B	2.5	52
4	75	5	12	12	75%-60% Gelatin—Semigelatinous	B	3.1	53
6	91	6	15	20	75%-60% Gelatin	T	3.0	56
7	91	6	16	20	75%-60% Gelatin	T	3.0	57
6¼	95	5	15	20	60%-70% Ammonia	B	3.0	60
6	61	6	18	20	70%-60%-40% Ammonia	T	2.9	62
6¼	55	5	16	18	60% Gelatin—Semigelatinous—50% Ammonia	B	2.8	64
6¼	63	3	18	24	60% Gelatin—Blasting Agent LV	B	2.7	67
6¼	55	5	20	20	Blasting Agent HV	B	2.8	78
9⅝	60	—	24	24	65% Ammonia LV	T	2.8	80
6	52	2	16	19	60% Gelatin—Semigelatinous—40% Ammonia	B	3.0	82
5⅝	206	6	15	25	70%-40% Ammonia	T	3.7	85
5⅝	154	5	18	25	60% Gelatin—50% Ammonia	T	3.75	91
9	156	6	30	30	Blasting Agent HV	B	4.0	92
9	155	5	30	25	Blasting Agent MV	B	2.33	94

(*Continued on next page*)

For Construction, original data gave "Explosive ratio" as lb per cubic yd which has been changed to the reciprocal, cubic yd per lb. Original "Bit size" is shown as "Hole dia".
*LD-low density; LV-low, MV-medium and HV-high velocity; B-bottom, M-middle and T-top detonated; R-regular instantaneous electric cap; P-Primacord; S-millisecond delay cap; C-millisecond delay connectors.
**Tons per lb for Quarrying and cu yd per lb for others.

Line No.	Formation & stratification (numbers indicate ft)		Shovel & output (cuyd)(cuyd/hr)		Crusher size (in.)	Drill type & speed (ft/hr)		Bit type & life (ft/sharp X sharps)	
101	Mica Schist	blocky	2½		30 x 42	Qmaster	15	Carbide	1700x
103	Mica Schist	seamy	2½		30 Cone	IR Down Hole	32	Carbide	3000x
105	Limestone	massive	2		36 x 42	Churn	3		900x
STRIPPING									
1	Ss 3–4/S 35–40		2½	300		Auger	60	Finger	200
3	L 10/Ss 40		5½ D	200		Auger	45	Carbide	250
5	S 27		2½	175		Auger	80	Throw Away	200
8	C 5–10/Ss 20–25/S 10–18		12½ D	410		Auger	75	Carbide	—
13	C & S 25/L 6/Ss 6/S 18		13 D	300		Auger	30	Carbide	1000
14	C—Ss 3–4—Sl		2½–1¾	—		Auger	120	—	—
15	S		5½	330		Auger	60	—	500
18	Ss—S		7 D	400		Auger	80	—	1000
20	Ss—S		5½	330		Auger	60	—	500
21	Ss—S		3	150		Auger	60	—	300
23	Sl		5½	330		Auger	60	—	500
24	C 5–8/S 12–16/Ss 12–14		4½ D	250		Auger	50	Finger	35–70
25	Ss 48		9 D	300		Auger	110	Finger	250
26	Ss 48		10 D	300		Rotary	80	-	3000
30	Ss 45		2½	—		Auger	40	Finger	150
34	L 6/Sl 2/C 6/Cl 2/L 18–20		17 D	450		Rotary	40	—	7000
36	Ss 10/L 8/S 12		5½ D	200		Rotary	60	—	2000
38	Ss 20/S 30		14 D	840		Rotary	13	—	9000
42	Ss—S		5½	330		Rotary	45	—	800
43	Ss—S		5½	330		Rotary	45	—	800
44	Ss—S		3	130		Rotary	60	—	650
46	Sl—C—Sl		5½	330		Rotary	60	—	800
CONSTRUCTION									
1	Shale	¼ inclined	2½	120		T-500	30	Carbide	625 x 8
3	Shale	⅓ horizontal	2½	200		Air Trac	50	Carbide	450 x 9
4	Shale	1 inclined	3½	210		Hvy. Wt. Rot.	40	—	1000
5	Shale	10 horizontal	5½	375		Joy Challenger	100	Carbide	3000
6	Glacial Till	solid	5	300		Rotary	40	—	—
8	Shale	inclined	2½	300		Wagon—4 in.	55	Regular	400 x 3
9	Sandstone (H)	12 horizontal	2½	90		HW Rotary	27	—	—
11	Sandstone	5 horizontal	2½	150		HW Rotary	50	—	—
14	Sandstone	laminated horiz.	3½	250		Vert. Auger	63	AP-2 Carbide	—
18	Sandstone	1 inclined	2½	130		Quarrymaster	28	Carbide	70
24	Felsite	4–6 folded	2½	100		Wagon X=71	25	Carbide	40 x 8
25	Schist	½–2 folded	2½	110		T-500	30	Carbide	90 x 8
26	Schist	¼–2 inclined	4½	175		GD-125 Air Trac	35	Carbide	187 x 12
27	Sandstone Cong.	2 folded	2½	200		Air Trac	50	Carbide	60 x 5
29	Sandstone	1½–2 horiz.	2½	—		IR Down Hole	25	Carbide	50 x 8
32	L'Stone & Schist	12 horizontal	2½	170		Wagon X-71	36	Regular	50 x 3
37	Limestone	solid inclined	1¾	105		Wagon—4½ in.	32	Regular	63 x 3
40	Limestone	various vertical	1½	100		Wagon—4 in.	40	Regular	150 x 3
42	Granite	4–6 joints igneous	3½	125		T-500	25	Carbide	30 x 8
43	Granite	3–5 horizontal	4	125		Air Trac	40	Carbide	48 x 9
44	Trap Rock	¼ horizontal	3½	260		Wagon—4 in.	45	Carbide	80 x 8
45	Granite	3 folded	2½	190		Air Trac	30	Carbide	30 x 6

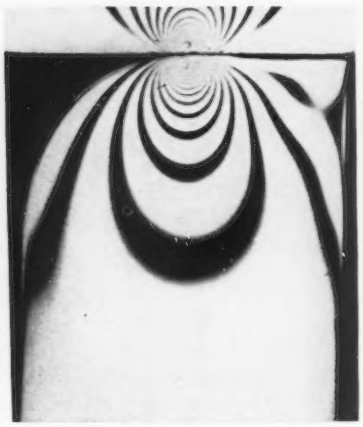
NOTES: Data omits mention of any chambering.

For Quarrying, original data gave "Face height" to which "Sub drill" footage has been added to give "Hole depth".

For stripping, "Formation" column shows thickness of formations from top to bottom: C-clay; Cl-coal; G-glacial drift; L-limestone; S-shale; Sl-slate; Ss-sandstone. In "Shovel size" column, D-dragline. In "Hole depth" column, H-horizontal holes. Original data gave "Bit size", now retitled "Hole dia".

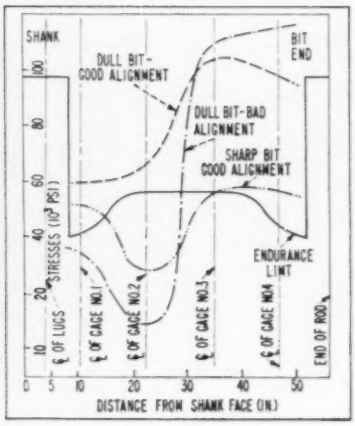
Hole dia (in.)	Hole depth (ft)	Sub drill (ft)	Spacing (ft)	Burden (ft)	Explosive & method of detonation*		Explosive ratio**	Line No.
6¼	135	10	9	45	75%–60% Gelatin—65% Ammonia	B	2.2	101
6	108	8	20	24	Blasting Agent HV	T	3.5	103
7	175	10	25	30	Blasting Agent HV	B	5.5	105
6	36–40 H		10	42	40% Ammonia	P	2.8 cu yd/lb	1
8	60 H		30	30	Blasting Agent + Primer	P	5.5	3
6	42 H		15	27	Blasting Agent + Primer	P	5.25	5
6	90 H		17	44	LD Ammonia	P	5.6	8
6–8	66 H		18	55	40% Ammonia	P	5.7	13
6	60 H		15	20	50% Ammonia	P	1.0	14
6¼	60 H		12	45	LD Ammonia	S	8.0	15
6¼	50 H		18	40	LD Ammonia	P	8.3	18
6¼	60 H		18	45	LD Ammonia & Blasting Agent + Primer	P	6.0	20
6¼	60 H		20	30	50% Ammonia & Blasting Agent + Primer	P	5.3	21
6¼	60 H		18	50	Blasting Agent + Primer	P	6.6	23
6	35		15	15	Blasting Agent + Primer	PS	2.5	24
6	48		15	15	LD Ammonia	S	4.5	25
6¼	48		15	15	LD Ammonia	S	4.5	26
6	45		10	10	LD Ammonia & Blasting Agent + Primer	P	2.5	30
8½	30		20	22	Blasting Agent + Primer	PC	3.0	34
6¼	30		15	15	40% & LD Ammonia	PS	2.0	36
10¾	55		36	30	Blasting Agent + Primer	P	5.0	38
5⅝	45		15	18	LD Ammonia & Blasting Agent + Primer	P	3.0	42
5⅜	40		18	18	LD Ammonia	P	3.2	43
5⅜	40		16	18	Blasting Agent + Primer	P	2.1	44
5⅜	45		16	16	Blasting Agent + Primer	P	4.25	46
4	30	3	12	12	40%–Gelatin (3″ x 20″)	B/S	2.0	1
2½	20	2	9	9	40%–Gelatin (2″ x 16″)	B/S	2.5	3
6	50	5	15	15	75%–60% Gelatin & Semigelatinous (5″ x 25#)	B/S	1.0	4
4	10	2	14	12	40% Ammonia (3″ x 16″)	B/S	2.0	5
6¼	25	0	25	25	40% Gelatin (5″ x 25#)	B/S	3.3	6
1¾	18	1	6	6	40% Ammonia (1½″ x 8″)	B/R	2.2	8
6¼	35	6	10	10	60% Gelatin & Semigelatinous (5″ x 25#)	T/P	0.5	9
6¼	40	6	12	12	60% Gelatin (5″ x 25#)	B/S	0.8	11
—	36	6	15	15	65% Ammonia (4½″)	B/S	3.0	14
5	26	3	12	12	Semigelatinous & LV Blasting Agent (4½″ x 16⅔# & Bag)	B/S	0.9	18
2¼	9	2½	4	4	40% Gelatin (1½″ x 2″)	B/S	1.3	24
4	30	3	12	12	40% Gelatin (3″ x 23″)	B/S	1.3	25
3	28	2	7	8	60%–40% Gelatin (2½″)	B/S	0.8	26
3½	30	3	10	8	40% Gelatin & Semigelatinous (3″ x 16″)	B/S	1.5	27
6	27	3	14	12	Semigelatinous & LV Blast. Agt. (5″ x 25# & Bag)	B/S	0.7	29
2¾	18	3	6	6	60% Ammonia (1½″ x 8″)	B/S	1.0	32
1¾	18	2	5	6	60% Gelatin & Semigelatinous (1½″ x 12″)	B/S	2.0	37
1⅞	8–10	1	5	5	40% Gelatin (1½″ x 8″)	B/S	1.4	40
4	30	3	10	10	Semigelatinous & 65% Ammonia	T/PS	0.9	42
3	50	5	8	8	Semigelatinous (2″ x 16″)	T/PS	0.8	43
2½	24	2	7	7	40% Gelatin (1½″ x 12″)	B/S	1.7	44
2½	30	2	6	6	40% Gelatin (2″ x 16″)	B/S	1.2	45

For Construction, original data gave "Explosive ratio" as lb per cubic yd which has been changed to the reciprocal, cubic yd per lb. Original "Bit size" is shown as "Hole dia".
*LD-low density; LV-low, MV-medium and HV-high velocity; B-bottom, M-middle and T-top detonated; R-regular instantaneous electric cap; P-Primacord; S-millisecond delay cap; C-millisecond delay connectors.
**Tons per lb for Quarrying and cu yd per lb for others.



DISTRIBUTION of stress in shank (photoelastic view) shows benefits of rounding corners. Recently other studies indicate harder shanks can be used.

TIME PLOT (oscillogram) of stress in rod during drilling shows complex wave of tension and compression that results from rock reaction and rod and bit effects.



VALUE of stress, measured by strain gages on surface of rod during drilling, often exceeds endurance limit and is greatly affected by drilling conditions.

Percussion Drill Steel Facts of Life

ALTHOUGH PURCHASE COST of percussion drill steel averages only about one cent per ton of rock mined, the cost of handling and fabricating is considerably higher. Data is lacking on full cost but the efforts expended by manufacturers and operators is evidence that rod life is an important element of drilling cost.

Service failure of drill rods is due to fatigue failure in the surface layer, usually caused by tension. This statement stands in full view of the fact that many failures start at the waterhole.

Failure Mechanism

The mechanism of failure in drill steel—like any polycrystalline material—has been explained in a simplified manner by Dr. T. W. Wlodek of the department of Mines and Technical Surveys, Ottawa, Can.:

"When the magnitude of an externally applied dynamic load reaches a value which produces, along various atomic crystal planes, a shear stress that exceeds the elastic limit in shear, a local plastic deformation (slip on atomic planes) takes place. During this initial local plastic deformation, so-called strain hardening or cold-working appears. If the magnitude of resultant alternating shear stresses resolved along atomic plane of least resistance to slip is within certain limits, further slip is stopped and material shows no further local changes. This is safe range of stresses, and failure is not expected. [Ed.—This is the fatigue or endurance limit.]

"If external alternating load exceeds the critical value, local plastic deformation is produced which exceeds the limiting range of crackless deformation. Small cracks or discontinuities result. During further alternating loading, these local cracks grow in number and size. If they reach a critical saturation a nucleus of fatigue is formed and eventually the material fails.

"Fatigue fracture of mining drill rods starts from a nucleus of fatigue, usually coinciding with point of expected maximum stress and a local stress concentration. Failure continues progressively during cyclic loading until cracked portion breaks suddenly due to overloading."

The fracture after failure often shows concentric arcs of varying smoothness. The center is the nucleus of failure and is smoothest because it was rubbed longest by action of the oscillating tension-compression loading. Area broken last, often largest, is coarser and more crystalline.

There are many factors that influence this mechanism of failure. Both geometric and compositional effects are generated in the manufacturing, fabricating and drilling processes.

In manufacturing, during ingot casting and rolling, a large number of small pits, sharp notches and different irregularities of geometrical and metallurgical origin are formed on the surface of mining drill rods. Because of their shape, they introduce large local stress concentrations which may range up to two or three times the normal stress obtained by direct measurements or by calculations. Values depend on radius (sharpness) of the root, and dimensions. Plastic flow may relieve the large local stresses during cyclic loading, but, if critical amount of mixed-up plastic flow under tension-compression stresses is exceeded, a nucleus of failure will be formed. Smoothing of the surface can counter this condition.

Surface decarburization is usually present in the "as-rolled" rod and this introduces a layer of lower mechanical strength as compared to the core. Recarburization can correct this.

Fabrication of the final rod adds more problems. Any heating may run the risk of increasing the surface decarburization and changing the microstructure to the detriment of strength. Careful attention to steel makers' data sheets will prevent this. The main dangers are heating to too high a temperature, holding too long at the specified temperature, subjecting to forge blast and using an oxidizing atmosphere.

Metallurgical notches—soft, hence low strength, zone between heat-treated and untreated portions of steel—are an evil originating in the heating necessary for forging, the annealing necessary for machining

and the hardening and tempering essential for service. Kemsley (Trans. Australian IMM 1955) said he found 78% of rod failures occurred in such spheroidized carbide zones which also accentuate corrosion. These zones can be completely eliminated only by heat-treating the entire rod as the last step in fabrication. But they can be "smoothed out" somewhat by "overlapping" the later heating, i.e., heating an additional 3 to 6 in. of rod for 2 to 4 minutes before quenching and doing the same during tempering.

Quenching itself may be a factor. If—to develop maximum hardness—the final quench is too rapid, surface cracking may result.

Residual stresses in the fabricated rod can have detrimental as well as beneficial effects on life. Residual tension stresses at surface aid formation of micro-cracks. For instance, Gardner-Denver found this to be reason heat-treated rod life for carbon was only one-fourth that for alloy, despite same hardness and no notches present: as a consequence of different reaction to heat-treat, pre-load tensile stress in surface of water hole was 50,000 psi for carbon rods as compared to zero in alloy rods—the carbon rods tending to fail at water hole, the alloy rods from outside.

Residual surface compressive stresses, on the other hand, will inhibit widening of micro-cracks due to tension. Ingersoll-Rand's cold "Jack-rolling" of undercut at beginning of threaded attachment has this prestressing effect.

Surface treatments on the final fabricated rod can help improve life by raising rod strength. Metallurgical surface treatments raise surface hardness either by changing composition (i.e., absorbing carbon or nitrogen into the surface) or by heat-treating (i.e., quickly heating surface by flame-torch or electric-induction and then quickly quenching). They also leave the surface under residual compression. On the other hand, mechanical surface treatments aim at prestressing the surface to leave it in residual compression by shot-peening (i.e., peening the surface with high velocity steel shot), spiral-rolling (i.e., impressing grooves on the surface), et al. They also raise surface hardness by cold-working and some also smooth the surface. Mechanical treatments can be effective after a metallurgical treatment.

In using the rod additional factors influence failure.

Design of the rod is one. Geometrical shape, orientation and dimensions of connections, collars, markings, shank faces, etc., can cause high local stress concentrations. While complete elimination of all these elements may be difficult, reducing the angle and rounding the apex of any junction can help. As Floyd R. Anderson, assistant manager with Gardner-Denver Co. at Denver, Colo., says, "It was soon learned in the development of carburized steels that mechanical design was of importance equal or greater than metallurgical refinements. Reverse buttress threads were found superior to lamp-socket type. Friction (taper or straight) type bit connections are preferred over lamp-socket threaded. External corners of shank striking ends, lugs and collars must incorporate generous radii to avoid early chipping in service." (See illustrations.)

Collarless rods can be used in drills employing an anvil block, e.g. stopers. But the block causes some loss in energy and pulling the rods must not be a problem. Friction-held detachable collars are another solution that has been reported in limited use. The one-piece rod with integral bit has the advantage of no connections. Atlas Copco's flat, flexible steels up to 33 ft long capitalize on this.

Water has a detrimental effect. Most obvious fact is that in its presence there is no fatigue limit. Moisture accelerates normal rust-pitting. In addition, its corrosive action is intensified by anodic conditions at points of local stress concentration. Many new pits are formed and old ones extended. Furthermore, impure mine water reduces surface hardness and other mechanical properties due to the Rehbinder effect of active surface agents penetrating deep into strained crystals. Raising corrosion resistance by changing composition can reduce water effects. Chemical coatings have been introduced and claimed highly effective. Adding chemicals to water has been suggested, too. And lining the water hole with corrosion resistant metal has proven successful (the steel is cast around a tube which decreases in size with the rod during rolling).

Abuse deserves emphasis. For instance, nicks result in local stress concentrations like any surface imperfection. Care is the answer.

Stress in a Drill Rod

Stresses developed in a drill rod are worth some consideration. The applied working stress is one of compression—impact of a hammer on the shank and reaction of the rock through the bit. Frequency of blows is 600 to 2500 per minute; energy per blow, 20 to 200 ft-lb. It now appears that 70 to 90% of the hammer's energy is lost between shank and bit due to joints, work of straining and damping effect of steel.

Tensile stress is critical. Its magnitude has been measured with strain gages and has been found to exceed 120,000 psi. As mentioned before, microscopic stress raisers may multiply this several times. Compressive and shearing stresses are also of some interest. But torsion is of minor importance because in percussion drilling rotation is only meant to turn the bit after it bounces free of the rock.

The shank face must not fail by chipping or plastically deforming under impact. On common percussion drill rods the area is sufficient to keep average stress below the yield limits of prepared steel. But on relatively thin tubing used with some of the new large drills, upsetting (plastic flow) does become a problem. Of course if stress is not applied to full area due to misalignment or misshape, any steel may be overloaded and fail.

In the rod, the compressive wave caused by the impact is a longitudinal (sound) type with the associated compression-tension stresses. It travels about 16,000 fps. When it is reflected from a boundary it changes to a tension wave. Thereafter, as the waves travel back and forth a complicated pattern develops. Geometric and compositional irregularities add to the complexity. The damping effect of steel absorbs the wave's energy. And the reaction of the rock varies. Failure to maintain feed thrust plays a large part in the detrimental effect of this vibration.

The rod is a column and as such develops bending stresses. This brings into play moment of inertia, unsupported length-minimum width ratios, end conditions, etc. In bending, the highest stresses develop in the surface farthest from the center; and for a given maximum outside diameter, the round (circular) cross-section is strongest.

Wider use of long hole drilling and longer rods, and larger machines and larger bits which involve heavier blows create acute problems. So do the more efficient, coarser chipping and faster penetrating bits which require larger flushing holes. As Dr. B. F. Shepherd, chief metallurgist with Ingersoll-Rand Co. at Phillipsburg, N.J., says, "Unfortunately, increases both in length of steel and in

diameter of center hole each causes a sharp decrease in critical column load (i.e., minimum load to cause buckling)." Starting on an irregular surface, long unsupported or unguided lengths, misalignment, dull bits and excessively heavy blows in hard rock also accentuate the bending tendency.

At the attachment, conditions exist which are a combination of those at the shank and in the rod-column. This element of the rod is very sensitive to geometric design. Close tolerances in fabrication and tight unions in assembly are important. Fretting (abrasion-corrosion) is often an added problem. Dissimilar, soft metal shims or dry film lubricants may help.

Composition and Heat-Treat

Composition and heat-treatment have a major role in the drill steel story. Their effects are interrelated. Essentially, the mechanical or working properties of steel—an alloy of iron and 0.01 to 2.00% carbon with other elements—are based on the distribution and amount of the hard compound Fe_3C, iron carbide or cementite. Thus carbon is the principal compositional factor. Heat-treatment is a process of changing the form and manner of distribution of the carbon by varying the rate of change and intensity of temperature.

Hardness (ability to resist indentation and abrasion) is probably the most important property of a steel. Strength in tension, compression, shear and fatigue are proportional to it. (Fatigue limit is considered about half the tensile strength which is about 500 times the Brinell Hardness Number or about 50 times Rockwell C value in this range.) Damping capacity is inversely proportional. Obviously then, higher hardness is the best single answer to longer life.

Unfortunately, brittleness (lack of ability to deform without failure) and notch sensitivity (tendency toward weakening if nicked or pitted) both appear to be proportional to hardness. This is detrimental because of the very high, short lasting stresses and rough handling that are common in drilling.

At any rate, as Dr. Shepherd says, "the ability of a steel to develop a desired hardness when cooled at a particular rate after heating is by far the most important property. In the shop this permits proper hardening of shanks, integral bits and attachments after forging or machining." Heat-treating controls the hardness actually developed in a given rod but composition determines the maximum possible hardness. In general, fastest cooling produces highest hardness and maximum possible hardness is a direct and practically solely a function of carbon content (at least up to 0.6% C). But to achieve the desired result, it is essential to follow manufacturers' data sheets closely.

Depth to which maximum hardness can be developed during heat-treating (called "hardenability) is essentially a function of how fast heat can be conducted out of the interior of the steel. Alloy content primarily governs this although grain size and carbon content are also interrelated.

Alloying elements can also enhance or inhibit certain properties. Some of their effects are not clear but apparently their use can result in rods with higher as-rolled hardness, increased toughness (combined strength and "anti-brittleness"), less precise heat treating temperatures and cooling rates, lower corrosion susceptibility and probably less notch sensitivity.

Steels and special treatments were further discussed in *E&MJ*, November 1957.

Drill Rod Testing

Testing drill steel and its components—bits and couplings—has long been of considerable interest to mining companies and steel manufacturers. The variable nature of rock and ores make many mining companies feel that it is necessary to conduct their own tests.

Several years ago the establishment of rock drillability tables by several researchers (*E&MJ*, May 1954, p G18 & February 1955, pp 124-125) gave a better basis for comparison. For the most part these are based on using a standard bit, steel and drill because the usual hardness tests—scratch, indentation, rebound or abrasion—do not correlate well with drilling results, especially not with percussion drilling which is closer to a crushing process.

Although final acceptance of any product should be based on actual field drilling tests, laboratory tests can be used for preliminary evaluation. For laboratory testing, either block tests or simulated tests can be used. Block tests use a standard rock block and standard drilling equipment. Simulated tests use fatigue testing machines.

In the last few years, fatigue testing machines having special adapters have been developed so that their results correlate well with field tests and give a method that is simple, very low cost, reproducible and renders numerical results, i.e., stress in psi and life in number of cycles to failure. (Wlodek, T. W., CIM Trans. Vol LVI 1951 et seq.; also see *E&MJ*, November 1957).

For field tests the use of statistical methods is essential for accurate, useful results. An excellent report on such a setup was given by C. Dahlin in Proceedings of Second Annual Symposium on Mining Research (Bull. 94, University of Missouri School of Mines, Rolla, Mo., 1957).

Pick Your Drill Steel From These Manufacturers' Lists

Designation	Use[1]	Analysis (Max./min. %) C	Mn	Si	Ni	Cr	Mo	Other[2]	BHN[3]	Shapes & Sizes[4]	Advantages & Special Remarks[5]
Acme Machinery:											
D	P	0.80	0.20	0.15	—	—	—	—	240/265	Hh: ⅞, 1; Rh: 1⅛,1¼	Consistent forging & heat treat control
S	P	0.80	0.20	0.15	—	—	—	—	240/265	Rh: 1½	
D	P	0.95	0.30	0.15	—	1.30	0.35	—	362/393	Hh: ⅞, 1; Rh: 1⅛, 1¼	
Atlas Copco (Sandvik):											
16C2Mo	Psic	0.95	0.3	0.2	—	1.0	0.2	—	380	Rh & Hh: ¾, ⅞, 1 Fh: 12x26mm	Flexible (8 ft radius), to 10 meters long
4N3C2Mo	Pd	0.25	0.5	0.2	3.0	1.2	0.25	—	360	Rh & Hh: ⅞, 1, 1¼, 1½, 2	

Pick Your Drill Steel (Continued)

Designation	Use[1]	Analysis (Max.,min. %) C	Mn	Si	Ni	Cr	Mo	Other[2]	BHN[3]	Shapes & Sizes[4]	Advantages & Special Remarks[5]
Bethlehem Steel:											
Hollow	PsdS	0.80	0.20	0.15	—	—	—	—	223	Rh: ⅞, 1, 1⅛, 1¼, 1½, 2; Hh & Qh: ⅞, 1, 1⅛, 1¼	Controlled hardenability and grain size for resistance to progressive fatigue failure and ease and uniformity for heat treatment.
Ultra-Alloy hollow	PsiicdS	0.95	0.30	0.25	—	1.30	0.35	—	363	Rh: ⅞, 1, 1⅛, 1¼, 1½, 2; Hh & Qh: ⅞, 1, 1⅛, 1¼	Increased hardness for improved physical properties & service life. Can be used with carbide detachable bits or integral forged carbide tipped bits.
Brunner & Lay:											
Standard carbon	Psd	0.83	0.23	0.13	—	—	—	*P<0.04 S<0.04	—	H: ⅞, 1; R: 1, 1⅛, 1¼	Can be reconditioned by average shop
Sectional carbon	PsdS	0.83	0.23	0.13	—	—	—	P<0.04 S<0.04	—	H: ⅞, 1; R: 1; 1⅛, 1¼, 1½	Can be reconditioned by average shop
Sectional carbon	Plds	0.83	0.23	0.13	—	—	—	P<0.04 S<0.04	—	R: 1½, 1¾, 2	Can be reconditioned by average shop
Standard alloy	Psd	0.95	0.35	0.30	—	1.30	0.33	P<0.03 S<0.03	—	H: ⅞, 1	Greater resistance to fatigue
Sectional alloy	Psds	0.95	0.35	0.30	—	1.30	0.33	P<0.03 S<0.03	—	H: ⅞, 1	Higher hardness gives longer thread life, especially desirable in long hole drilling.
Intraset	Psic	0.95	0.35	0.30	—	1.30	0.33	P<0.03 S<0.03	—	H: ⅞, 1; R: 1⅛, 1¼	Carbide inserted rods permits smaller hole drilling with a given section of steel and eliminates threaded connection.
Crucible Steel:											
Crusca (straight carbon)	PsIidS As	0.80	0.28	0.15	—	—	—	—	217 — 302	Rh: 1 to 2; Hh: ⅞ to 2; Qh: ⅞, 1(a); Dn: 1½; Wa: 1⅜	All purpose. (a)R, H, Q, O-s: ½-2½; Cruciform-s: ¾-2½.
CA double diamond alloy	Psiicds	0.90	0.30	0.27	—	0.95	0.32	—	331 — 477	R, H, Q-h: to 1¼, 1 & 1 respectively	High as rolled hardness, greater strength and resistance to fatigue and superior resistance to wear and abrasion.
EEEE alloy	PsIicdS	0.27	1.00	0.65	0.25	2.15	0.30	—	352 — 461	R, H, Q-h: to 1¼, 1⅛ & 1 respectively	For rods with detachable bits. Less critical treatment temperatures. Ideal for carburized and hardened rods.
AISI 4320	PsIdS	0.17 — 0.22	0.45 — 0.65	0.20 — 0.35	1.65 — 2.00	0.40 — 0.60	0.20 — 0.30	P<0.04 S<0.04	241 — 321	R, H-h: to 1¼ & 1⅛ respectively	Especially for carburized and hardened rods.
Gardner-Denver:											
Made-up drill rods, carburized shot peened.	Pd	0.17 — 0.22	0.45 — 0.65	0.20 — 0.35	1.65 — 2.00	0.40 — 0.60	0.20 — 0.30	—	190 — 220	Hh & Qh: ⅞; Rh, Hh & Qh: 1; Rh: 1⅛, 1¼	For reverse buttress threads or taper socket connections only. Shot peening and carburizing provides favourable surface structure and increases service life.
Made-up drill rods, plain carbon shot peened.	Psd	0.80	0.30	0.15	—	—	—	—	250	Hh & Qh: ⅞; Rh, Hh & Qh: 1; Rh: 1⅛, 1¼	For threaded or taper bit connections. Shot peening provides favourable surface structure and increases service life.
Sectional drill rods, carburized shot peened.	PsiS	0.17 — 0.22	0.45 — 0.65	0.20 — 0.35	1.65 — 2.00	0.40 — 0.60	0.20 — 0.30	—	190 — 220	Hh: ⅞, 1, 1¼, 1½, 1⅝	Reverse buttress threads, complete range hole sizes, excellent hole cleaning thru long rod strings due to coupling & ring seal shank design. Favourable surface stresses from carburizing and shot peening.
Ingersoll-Rand:											
Plain Carbon	Psic, Psd, Pld, As	0.75 — 0.85	0.15 — 0.40	0.10 — 0.30	.25x	.15x	.05x	V optional	240 min.	R, H, Q, O, F, D, W-h, S	Can be used for integral steel.
Alloy Cr Mo	Psic, Psd, Pld	0.90 — 1.05	0.20 — 0.45	0.15 — 0.35	—	0.90 — 1.40	0.17 — 0.45	—	321 — 477	R, H, Q, O, F-h	Can be used for integral steel.
Alloy Mn G Mo	Psd, Pld	0.25 — 0.30	0.80 — 1.20	0.50 — 0.80	0.25 — 0.40	1.00 — 2.40	0.25 — 0.35	—	357 — 415	R, H, Q-h, S	Can also be specially heat treated.
Alloy Ni Cr Mo	RCld, Psd, Pld	0.17 — 0.22	0.45 — 0.65	0.20 — 0.35	1.65 — 2.00	0.40 — 0.60	0.20 — 0.30	—		Hh, Rt	Special heat treatment.
Alloy Cr Mo	RCld, Pld	0.38 — 0.43	0.75 — 1.00	0.25 — 0.35	25x	0.80 — 1.10	0.15 — 0.25	—	260 — 310	Rt	Normalized & tempered.
Acker Drill:											
C1035 cold drawn seamless steel tubing	D	—	—	—	—	—	—	—	—	Rt: 1⅝(E), 1¾(EW), 1⅝(A), 1¾(AW), 1⅞(B), 2⅛(BW), 2⅜(N), 2⅝(NW)	All used with flush couplings. All have square threads per D.C.D. M.A. standards.
Boyles Bros. Ltd. (Can.):											
	D	0.36 — 0.44	0.60 — 0.90	—	—	—	—	P 0.04 S 0.05	200	Rt: 1(XR), 1⅛(XRT), 1⅝(E), 1¾(EW), 1⅝(A), 1¾(AW), 1.9063(B), 2⅛(BW), 2⅜(N), 2⅝(NW), 3⅛(H)	Internal upset ends.
Rod Coupling	D	0.38 — 0.43	0.75 — 1.00	0.20 — 0.35	—	0.80 — 1.10	0.15 — 0.25	P 0.04 S 0.04	265		
Drilling Accessory:											
AISI C-1041 Grade D Tubing	D, R, RC	—	—	—	—	—	—	—	—	Rt: 1¾, 1¾, 2⅛, 2⅜, 2⅞	
Failing, George E:											
Seamless tubing	RC, R	0.36 — 0.44	1.35 — 1.65	—	—	—	—	—	201	Rt: 2⅛, 2⅞	
E. J. Longyear:											
AISI 1035	D, RC, R	0.38 — 0.32	0.90 — 0.60	—	—	—	—	—	271 — 237	Rt: 2⅛, 1⅜, 1¾, 1⅛	

Key to abbrevations

1. Use these abbreviations: C–churn; D–diamond drill; RC–rotary with roller-cone bit; A–auger; P–percussion; R–rotary with drag bit; add these letters applicable: s–only applicable to bit gages under 3-in.; l–applicable only to bit gages over 3-in.; i–with integral forged bit; ic–with integral forged tungsten carbide tipped bit; d–with detachable bit; S–sectional rod. For example, steel that can be used for percussion drilling using integral forged bits under 3-in. gage that are tipped with tungsten carbide inserts would be indicated by "Psic".
2. Specify chemical symbol.
3. Brinell Hardness Number of "as rolled" surface, showing maximum/minimum.
4. Use these abbreviations: R–round, H–hexagonal, Q–quarter octagon, O–Octagonal, F–flat, D–diamond auger, W–wing auger, h–hollow, s–solid, t–tubing. Specify any other using a footnote "a" in Remarks.
   Designate size by maximum outside diameter in inches.

Good Filing Keeps Knowledge

THE EXPONENTIAL rate at which technical literature seems to be increasing makes even cataloging it—much less storing and certainly reading it—a major problem for any progressive organization.

Three years ago *E&MJ* undertook to set up a coordinated indexing-filing-reference library scheme that would be simple yet broad enough to be quickly and easily used by a staff with varied interests and background; one that would be capable of handling a large volume of material; and one that would aid our objective of periodically summarizing world-wide advances in all phases of mining and our ever-present problem of answering inquiries. In addition it had to meet certain office space limitations.

In reviewing the several widely used formal systems and the many personal schemes that have been published, they generally seemed too rigid, too complicated, not specific enough or not properly balanced for our use without revision. Probably no system can be perfect in all respects but the one we adopted has proven effective and it may help you in keeping the latest knowledge at your fingertips.

Certain aspects of our system are peculiar to news gathering and publishing. These are not included in this outline.

The scheme can be used for as comprehensive a coverage as is desired and it can be used separately for indexing or for filing. Or the two may be combined. For indexing alone, small file cards can be used and, if desired, they can contain an abstract.

We use the system separately for indexing *E&MJ* (no abstracts) and as a combination filing-indexing system for other material. This latter file is restricted to only the most significant literature and no attempt is made to include all literature on a subject. In the subject files described later, we have a standard 8½x11-in. sheet at the beginning of each category for use as a running index (with brief description) of only material that is *not* stored in that file division. We use separate sheets for individual abstracts, although this is rarely done.

This procedure meets our needs because we have ready access to comprehensive indices such as the *Engineering Index* and the *Applied Science & Technology Index* (prior to 1958, *Industrial Arts Index);* and because we maintain our own file of abstract journals such as published by IMM (London), Battelle Institute, USGS, AGI, et al, and indices of USBM, USGS and technical magazines (including a monthly world-wide selected index in *Mining Magazine* [*London*]). Our scheme also recognizes that much of the technical literature can be furnished in original form or photostat copy by the Engineering Societies Library (29 West 39 st., New York, N. Y.) or by the publisher. But it is wise to check such sources before discarding material, especially special releases.

E&MJ's system requires that specific technical personnel be assigned responsibility to scan, select and classify material of interest to a limited phase of the industry. They also must periodically "weed out" the files pertaining to their phase. It is essential that the entire staff cooperate in referring to the proper responsible "scanner" any articles that may appear significant, even if doubtfully necessary.

To keep the system flexible enough to accomodate changes and meet special temporary needs within the basic framework, individual staff members may add subdivisions as desired within the "Specific" technical subjects (described later) but actual subdividing is done only as needed (our current subdivisions are shown in italics in the outline).

Material is placed in the most specific category appropriate to the material. Cross reference note sheets or reproduced copies are used only when necessity demands it.

All items are dated and labeled—when at all possible—as to source, technical subjects and/or equipment classification (include manufacturer and model), commodity, location, company and mine—if not otherwise apparent. The selected filing category is circled.

Separate illustrative material—photographs, drawings, maps, etc.—are grouped together and placed within (at rear of) applicable category.

Material with which we are concerned, and some brief notes on how it is handled, is shown below.

Our subject files are divided into several broad categories—

Technology File [six 11x15x30-in. files] is arranged as shown in the functional grouping outline. An alphabetical listing of subject headings and cross references as used for the annual *E&MJ* index is on page 116. But besides this file and those special to our operation, we have certain files which may have some use in other organizations. Technological information applicable to only one specific piece of equipment, commodity or geographic locality is filed in these:

Equipment file [four file drawers] is divided into two sections: Units—individual equipment data subdivided according to headings as used for Buyers' Guide (see pages 217 et seq.) further subdivided alphabetically by manufacturer's name.

Companies—condensed general equipment catalogs arranged alphabetically by company name (cross-index parent and subsidiary).

Commodity File [four file drawers] is divided alphabetically by name of metal or non-metallic (i.e., final industrial-commercial product), subdivided alphabetically into mineral or ore name only as necessary. Separate subdivisions are used for Economics Legislation and for Technology within commodity divisions or ore subdivision.

Geographic File [four file drawers] is subdivided alphabetically by country, subdivided alphabetically by state (or province), then by district, then company and finally be mine or operatonal site. Continents are treated as equivalent to country and interstate regions as states. Separate subdivisions are used for Economics & Legislation and for Technology down through district.

How to Handle Various Literature

Periodical magazines—all issues of selected publications are shelved chronologically within alphabetical arrangement by titles. Significant articles are immediately indexed under appropriate category in subject files (described below). At the end of two years, significant articles are clipped and filed in appropriate subject files and rest of issue discarded. [One 3x4-ft bookcase, 33 publications]

Government, university and society papers and paperbound publications—selected complete issues or clipped portions are filed under appropriate category in subject files. Multi-topic issues are especially considered for cross-indexing or for placement in book library.

At Your Fingertips

Mining and equipment company publications—generally only clipped portions are filed in appropriate subject file.

Text Books—selected ones are shelved in arrangement similar to subject files (see below) but limited to a total of two or three for each "General" or "Specific" technical subject, each commodity and each country. [Four 3x4-ft bookcases, one each for: Exploration, Mining & Operating Services; Processing & General (dictionaries, handbooks, etc.); Commodity & Geographic; Economics & Legislation]

Abstracts, Indexes & Bibliographies—filed chronologically within alphabetical arrangement by publication or organization name. Especially significant abstracts and portions of other material are reproduced and placed in appropriate subject files. [Two file drawers.]

(Note: Top quality, surplus material is disposed of by sending to various schools and libraries.)

Functional Grouping of E&MJ's Technological Subject Headings

EXPLORATION
- Geology, General & Structural
- Geophysics
  - *Magnetic*
  - *Electromagnetic*
  - *Resistivity*
  - *Seismic*
  - *Gravity*
  - *Radioactivity*
  - *Other Methods*
- Geochemistry & Mineralogy
- Valuation & Examination

MINING
- PLACER MINING
- OPEN PIT MINING AND QUARRYING
- UNDERGROUND MINING
- WELLS & OTHER SPECIAL MINING
- Development, Mine
  - *Surface mining*
  - *underground mining*
  - *Underground mining*
  - *Shafts, Raised & Winzes*
  - *Adits, Tunnels, Drifts, etc.*
- Production (filed under Placer, Open Pit, Underground or Wells)
- Drilling, Boring & Cutting (for dredging & hydrauliking see Loading)
  - *Percussion*
  - *Churn*
  - *Rotary*
  - *Diamond*
  - *Jet piercing & Special*
  - *Special large hole (+12 in.)*
  - *Cutting, Ripping & Planing*
- Blasting
  - *Surface*
  - *Underground*
- Ground Control
  - *Surface*
  - *Underground*
  - *Natural*
  - *Timber*
  - *Structural steel*
  - *Rock bolts*
  - *Concrete & Grout*
  - *Fill*
  - *Other*
- Loading & Handling Muck (for continuous mining see Drilling)
  - *Placer & Surface Stripping*
  - *Pit & Quarry*
  - *Underground (& Gravity Passes)*
  - *Chutes, Feeders, Dumps, etc.*
- Transporting & Hoisting, Mine (for muck pumping see Water Control; for muck passes see Loading)
  - *Rail*
  - *Truck*
  - *Conveying & Slushing*
  - *Hoisting*
- Water Control & Pumping, Mine & Well
  - *Muck Pumping*

PROCESSING
- BENEFICIATING
- REFINING NONMETALLICS
- EXTRACTIVE METALLURGY
- PHYSICAL METALURGY
- Comminuting
  - *Crushing*
  - *Grinding*
  - *Pulverizing*
- Agglomerating (for sintering see Pyrolytic Processing)
  - *Flocculating*
  - *Balling & Briquetting*
- Sizing, Dewatering & Dust Collecting (for drying see Pyro. Pro.)
  - *Screening*
  - *Settling*
  - *Cycloning*
  - *Centrifuging*
  - *Filtering*
- Agitating, Mixing & Washing (for flotation see Concentrating; for screen or trommel washing see Sizing)
  - *Conditioning*
  - *Log Washing*
  - *Attrition & Drum scrubbing*
- Concentrating Solids (for washing see Sizing or Agitating; for centrifuging see Sizing)
  - *Hand sorting*
  - *Jigging*
  - *Tabling*
  - *Sluicing*
  - *Heavy media flotation*
  - *Froth flotation*
  - *High tension & electrostatic*
  - *Magnetic*
- Solution Processing (for molten salt electrolysis see Pyro. Pro.)
  - *Leaching & Dissolution*
  - *Chemical precipitation*
  - *Ion exchange*
  - *Solvent extraction & Amalgamating*
  - *Electrolysis*
- Pyrolytic Processing
  - *Drying*
  - *Sintering & Roasting*
  - *Retorting & Sublimation*
  - *Smelting & Halogenation*
  - *Molten salt electrolysis*
- Gaseous Processing (for retorting see Pyrolytic Processing)
- Materials Handling, Process
  - *Pumping*
  - *Conveying*
  - *Feeding*
  - *Storage*

OPERATING SERVICES see divisions
- POWER & POWER EQUIPMENT (for automatic controls see Communications)
  - *Electric*
  - *Internal combustion*
  - *Compressed air*
  - *Hydraulic*
  - *Mechanical transmission*
- MAINTENANCE & SHOPS
- COMMUNICATIONS & AUTOMATIC CONTROLS
  - *Communications*
  - *Processing controls*
  - *Mining controls*
- MATERIALS HANDLING, GENERAL CONSTRUCTION
- ENGINEERING & RESEARCH
  - *Surveying & drafting*
  - *Time & work methods*
  - *Sampling & Testing*
  - *Mathematics & Statistics*
- SAFETY & HEALTH
  - *Ventilation*
  - *Lighting & Sound*
  - *Accidents*
  - *Fire control*
  - *Pollution control*
- PERSONNEL & PUBLIC RELATION
  - *Organization*
  - *Employee relations*
  - *Housing*
  - *Communications & Public Relations*
- OFFICE & SUPPLY SERVICE
  - *Training & Selection*
  - *Accounting*
  - *Filing*
- COSTS (generally filed under specific subject)
  - *Mining*
  - *Processing*
  - *Exploration*

ECONOMICS, MARKETING & FINANCE

LEGISLATION & MINERAL POLICY

NOTE: Italics indicate current divisions of files.

Capitals indicate "General" subject headings under one of which all E&MJ articles are indexed.

Other titles are "Specific" subject headings under one or more of which E&MJ articles may be indexed.

Alphabetical List of Technical Headings and Cross References

Accidents see Safety
Accounting see Office & Supply Service
Adits see Development
Agglomerating also see: Pyrolytic Process (sintering)
Agitating, Mixing & Washing also see: Concentration (flotation); Sizing (screen & trommel washing)
Air Pollution Control see Safety
Alluvial Mining see Placer Mining
Amalgamating see Solution Processing
Assaying & Analyzing see Geochemistry
Augering see Drilling
Automatic Controls see Communications
Balling see Agglomerating
Beneficiating, Mineral also see: Processing
Blasting
Boring see Drilling
Briquetting see Agglomerating
Calcining see Pyrolytic Processing
Centrifuging see Sizing
Chutes see Loading
Classifying see Sizing
Comminuting
Communications & Automatic Controls
Compressed Air see Power
Concentrating Solids does not include: scrubbing and washing (see Agitating); Pyrolytic Processing; Solution Processing; Comminuting; Agglomerating; Sizing
Conservation see: Legislation; Personnel; Safety
Construction
Controls see: Power; Communications
Continuous Mining see Drilling
Conventions & Special Features also see name of society or convention
Conveying see: Transporting, Mine; Materials Handling
Costs also see specific subject
Crushing see Comminuting
Cyaniding see Solution Processing
Cycloning see Sizing
Development, Mine also see: Valuation (ore reserve calculation); Economics (financing); Exploration
Dewatering see: Sizing; Pyrolytic Processing (drying); Water Control, Mine
Drafting see Engineering
Drainage, Mine see Water Control
Dredging see: Placer Mining; Loading; Water Control (muck pumping)
Drifting see Development
Drilling, Boring & Cutting Rock & Earth also see Loading (dredging & hydraulicking)
Drying see Pyrolytic Processing
Dumping see Loading
Dust Collecting see Sizing; Safety
Economics, Marketing & Financing also see: individual commodities and countries; Legislation
Economic Geology see: Geology
Education see Personnel
Electric Power & Equipment see Power
Electrolytic Processing see Solution Processing or Pyrolytic Processing
Electrostatic Separation see Concentrating
Engineering & Research also see: Exploration; Geology; Geophysics; Geochemistry; Valuation; Personnel (education & training, selection)
Engines see Power
Evaluation see Valuation
Excavating see: Loading; Mining
Exhaust Scrubbing see Safety
Exploration
Explosives see Blasting
Exports see Economics
Extractive Metallurgy see Metallurgy
Feeding see: Materials Handling, Process; Loading, Mine Muck
Filtering see sizing
Financing see Economics
Fire Control see Safety
Flocculating see Agglomerating
Flotation see Concentrating
Gaseous Processing also see Pyrolytic Processing (retorting)
Gas-Gas Separation see Gaseous Processing
Gas-Liquid Separation see Sizing
Gas-Solid Separation see Sizing
Geochemistry & Mineralogy
Geology, General & Structural also see: Engineering (Surveying)
Geophysics
Gov't Agencies see Legislation
Gravity Concentrating see Concentrating
Grinding see Comminuting
Ground Control & Support
Hauling see: Transporting; Materials Handling, General
Health see Safety
Heavy Media Separation see Concentrating
High Tension Separation see Concentrating
Historical Features see Conventions
Hoisting see Transporting
Housing see: Personnel; Construction
Hydraulicking see: Placer Mining; Loading; Water Control (Pumping)
Hydro-Chemical Processing see: Solution Processing
Hydrology & Hydraulics see: Water Control, Mine; Materials Handling; Power
Imports see Economics
Industrial Engineering see Engineering
Ion Exchange see Solution Processing
Jigging see Concentrating
Labor see: Personnel (training, administration & management); Legislation; Costs; Engineering (time & work studies)
Land Rehabilitation & Reclamation see: Personnel; Legislation
Leaching see Solution Processing
Legislation & Mineral Policy also see name of country or gov't agency
Lighting see Safety
Liquid-Liquid Separation see Solution Processing
Liquid-Solid Separation see: Sizing; Pyrolytic Processing
Loading & Handling Mine Muck also see: Transporting; Drilling (continuous mining); Materials Handling (other than mine muck)
Lubrication see Maintenance
Magnetic Separation see Concentrating
Maintenance & Shops also see Power
Management see: Personnel; Office & Supply Service
Mapping see: Engineering; Geology
Markets see Economics
Materials Handling, Process, Mill & Plant for other than process see: Materials Handling, General; Loading, Mine; Transporting, Mine; Water Control, Mine
Materials Handling, Storing & Transporting, General also see: Loading & Handling Mine Muck; Transporting & Hoisting, Mine; Water Control, Mine; Materials Handling, Process; Office & Supply Service
Metallurgy, Extractive also see: Processing; Beneficiating
Metallurgy, Physical also see Maintenance
Milling see Beneficiating
Mineral Dressing see Beneficiating
Mineral Policy see Legislation
Mineral Resources see: name of Commodity and/or Country; Economics; Legislation
Mineralogy see Geochemistry
Mining also see: Exploration; Open Pit Mining and Quarrying; Placer Mining; Underground Mining; Wells & Other Special Mining
Mining Methods see Mining
Mixing see Agitating
Motors see Power
Muck Handling see: Loading; Transporting; Materials Handling
Nodulizing see Agglomerating
Office & Supply Service also see Materials Handling, General
Open Pit Mining & Quarrying also see Mining; Placer Mining
Ore Dressing see Beneficiating
Ore Passes see: Loading; Development
Pelletizing see Agglomerating
Personality Features see Conventions
Personnel & Public Relations also see Safety
Petrology see Geochemistry
Picking, Hand see Concentrating
Placer Mining also see: Mining
Pollution Control see Safety
Power & Power Equipment also see: Shops; Communications (automatic controls)
Precipitation see Solution Processing
Prices see Economics
Processing also see: Beneficiating; Refining, Non-Metallics; Metallurgy, Extractive
Production, Mine for production statistics see Economics or Country
Prospecting see Exploration
Public Lands see Legislation
Public Relations see Personnel
Pulverizing see Comminuting
Pumping see: Water Control, Mine; Materials Handling, Process; Materials Handling, General
Pyrolytic Processing
Quarrying see Open Pit Mining
Railroading see Transporting, Mine; Materials Handling, General
Raising see Development
Refining, Non-Metallics also see: Beneficiating; Processing
Retorting see Pyrolytic Processing
Research see Engineering
Roasting see Pyrolytic Processing
Rock Bursts & Rock Mechanics see Ground Control
Safety & Health also see: Personnel (housing, welfare, etc.);
Sampling see: Engineering; Valuation; Geochemistry;
Science see Engineering
Scraping see: Loading; Transporting
Screening see Sizing
Scrubbing see: Agitating; Safety (exhaust scrubbing); Gaseous Processing; Sizing
Separating see: Concentrating; Sizing; Solution Processing; Gaseous Processing, Pyrolytic Processing
Settling see Sizing
Shafts see: Development; Transporting
Shipping see Materials Handling, General
Shops see Maintenance
Sintering see Pyrolytic Processing
Sizing, Dewatering & Dust Collecting also see: Agglomerating (flocculating); Pyrolytic Processing (drying); does not cover ventilation or pollution (see Safety)
Sluicing see: Concentrating; Loading
Slushing see: Loading; Transporting
Smelting see: Pyrolytic Processing; Metallurgy, Extractive;
Societies see name of society
Solid-Solid Separation see: Concentrating; Sizing; Comminuting
Solution Processing also see: Sizing (solid-liquid separation, flocculating); Pyrolytic Processing (molten salt electrolysis)
Solvent Extraction see Solution Processing
Sorting see: Concentrating; Sizing
Sound Suppression see Safety
Spiral Concentrating see Concentrating
Stockpiling see: Legislation; Materials Handling, General
Stoping see: Underground Mining; Production
Stripping see: Open Pit Mining; Placer Mining; Development
Subsidence see: Ground Control; Safety; Legislation; Personnel
Subsidies see Legislation
Supply Service see: Office; Materials Handling, General
Surveying see Engineering
Tabling see Concentrating
Tariff see Legislation
Taxation see Legislation
Thickening see Sizing
Timbering see Ground Control
Training see Personnel
Transporting & Hoisting, Mine also see: Loading (feeding, muck passes and chutes, dumping); Water-Control, Mine (muck pumping); Materials Handling (other than mine)
Trucking see: Transporting, Mine; Materials Handling, General
Tunneling see Development
Underground Mining also see: Mining; Wells
Valuation & Examination, Mine & Prospect also see: Engineering; Economics
Ventilation see Safety
Wages see: Personnel; Economics; Costs
Warehousing see: Materials Handling, General; Office & Supply Service
Washing see: Agitating; Sizing
Water Control & Pumping, Mine also see: Safety (pollution control); Materials Handling, General (general pumping)
Water Purification & Pollution Control see: Safety; Solution Processing; Sizing
Welfare see: Personnel; Safety
Wells & Other Special Mining also see Mining

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Reagents for the Mining Industry
Flotation—Hydrometallurgy

Cyanamid supplies the widest range of metallurgical chemicals available from any single source. A few are pictured above.

AEROFLOAT® Promoters
AERO® Xanthates
AERO® Brand Cyanide
Sodium Cyanide
AEROSOL® Surface Active Agents
CYQUEST 40* Sequestering Agent
400, 700, 800 Series AERO® Promoters
600 Series AERO® Depressants
AEROFLOC® Reagents
AEROMINE® Promoters
AEROFROTH® Frothers
AERO® Thiocarbanilide 130

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EXPLOSIVES AND MINING CHEMICALS DEPARTMENT

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And in the heart of every borehole—where maximum blasting efficiency and water-resistance are required—you'll also find Cyanamid Explosives.

We have put all our years of knowledge into making a *complete line* of explosives . . . *engineered* to break ore loose in a form for most economical handling.

To assure you of maximum value for your money, Cyanamid Explosives are backed by the technical assistance of our experienced representatives. Their services and advice are yours for the asking. Quick delivery to your mine from our national network of plants and magazines. Make your next load of explosives CYANAMID!

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Explosives and Mining Chemicals Department
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THE CYANAMID LINE: High Explosives • Permissibles • Seismograph Explosives • Blasting Agents • Blasting Powder • Blasting Caps • Electric Blasting Caps • Blasting Accessories

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Manufacturers of a Complete Line of Quality Gear Drives and Flexible Shaft Couplings for Industry

Representatives and Distributors in most principal cities

Falk Standard Gear Drives

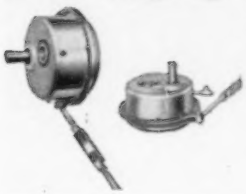
The helical and spiral bevel gears used in Falk gear drives assure highest attainable mechanical efficiency — 98½% per gear train under full load.

ALL-MOTOR MOTOREDUCERS *Package drives up to 75 hp capacity.*

A Falk All-Motor unit may be used with any standard foot-mounted motor within the rated capacity of the gear unit. Standard output speeds from 1.2 to 520 rpm (with 1750 rpm motors); ratios as high as 54,000:1 in semi-standard designs. All-steel construction. Integral units also available in the range from 1 to 40 hp.

Ask for Bulletin 3100.

SHAFT MOUNTED DRIVES *Up to 50 hp.*



Horizontal or Vertical Units

V-belt or chain connected to prime mover. Single and double reduction all-steel units in seven sizes provide choice of wide range of output speeds between 420 and 5 rpm. Maximum torque rating at low speed shaft: 31,500 lb-in.

Ask for Bulletin 7100.

SMALL SPEED REDUCERS *Up to 138 hp.*

◄ **Concentric Shaft** Ratios from 1.5:1 to 969:1. Max. torque rating at low speed shaft: 53,000 lb-in.

Right Angle ► Ratios from 5:1 to 1459:1. Max. torque rating at low speed shaft: 73,000 lb-in.

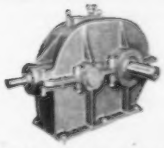
Ask for Bulletin 1105.

LARGE SPEED REDUCERS *Up to 3500 hp.*

Parallel Shaft

Up to 3500 hp. Ratio range: from 2:1 to 300:1. Max. catalog torque rating at low speed shaft: 1,950,000 lb-in.

Bulletin 1110B.



Right Angle Horizontal

Up to 1000 hp. Ratio range from 1.5:1 to 515:1. Max. catalog torque rating at low speed shaft: 569,000 lb-in.

Bulletin 2105A.

Right Angle Vertical

Up to 760 hp. Ratio range from 6:1 to 430:1. Max. catalog torque rating at low speed shaft: 714,000 lb-in. (Shafts up or down.)

Bulletin 2110B.

HIGH SPEED DRIVES *Reducers and increasers.*

◄ **Up to 225 hp.**
Maximum rpm — approx. 4500.
Bulletin 1106.

Up to 5000 hp. ►
Maximum rpm — approx. 10,000.
Bulletin 5105.

Special GEAR DRIVES *for any application.*

Special HIGH SPEED DRIVES *. . . over 50,000 rpm.*

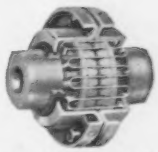
Marine PROPULSION DRIVES *turbine and diesel driven*

Falk Flexible Shaft Couplings protect the machines they connect.

STEELFLEX COUPLINGS

34 sizes covering a hp range from ½ through 72,000 hp at 100 rpm. Torsionally resilient grid-groove design cushions impact and starting loads as much as 30% and accommodates reasonable degrees of shaft misalignment which may occur between regular inspections.

Ask for Bulletin 4100.



BASIC TYPE F for 9 out of 10 applications, horizontal or vertical. Also dual-purpose designs for torque control, brake-wheel service, piloted shafts, etc.

AIRFLEX COUPLINGS

15 sizes covering a range from 5 through 2400 hp at 100 rpm. Ideal for applications which have irregular torque characteristics in driving or driven machines (internal combustion engines, compressors, etc.).

Ask for Bulletin 8100.

Designed for mounting shaft-to-shaft, shaft-to-flywheel, or shaft-to-flange.

FALK SINGLE HELICAL AND HERRINGBONE GEARS

Designed for any industrial application. Falk exclusive full-depth tooth form provides greater load-carrying capacity. AGMA ratings.

• •

Diameters up to 18 ft.
Face Widths up to 6 ft.

Diametral Pitch — ¾ to 6 dp.

• •

Hub or ring gears in solid or split designs.

Ask for Engineering Reports 6170 & 6171.

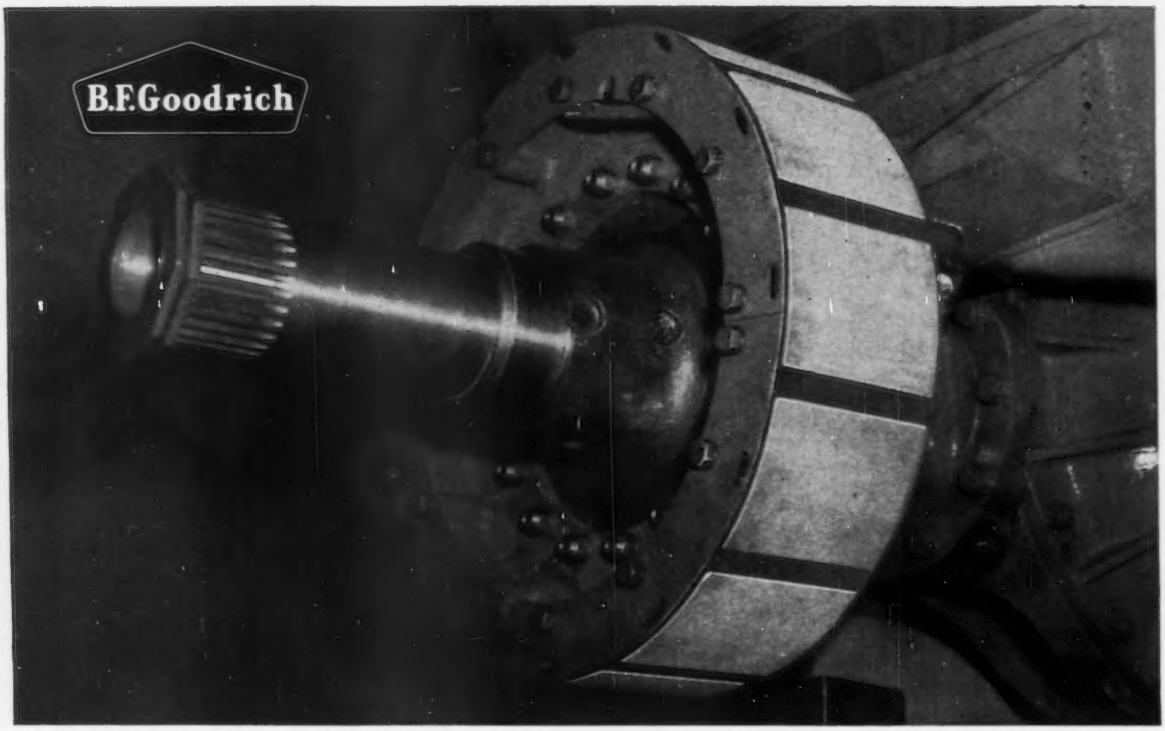
Hub Gears

Ring Gears

Mill Pinions

FALK

. . . a good name in industry



The *only* off-road brake with *full circle stopping power*

Tests prove the B.F.Goodrich Hi-Torque Brake can stop your heavy equipment faster, safer!

Tractor-Scraper Test

	B. F. Goodrich Hi-Torque	Conventional two-shoe brake
Stopping distance	41′ 9″	72′
Speed	14.83 mph	15.17 mph
Load	heaped	heaped

Two identical tractors and scrapers were used for this test. Unit fitted with B. F. Goodrich Brakes stopped almost twice as fast as unit using regular production brakes.

Off-Highway Truck Test

	B. F. Goodrich Hi-Torque	Conventional two-shoe brake
Deceleration rate	18 Ft/sec^2	7 Ft/sec^2
Speed	25 mph	25 mph
Gross vehicle weight	112,000 lbs.	112,000 lbs.
Wheel condition	sliding	rotating

Popular 24-ton capacity off-highway truck with original production brakes was run over test course. Immediately after fitting the same vehicle with B. F. Goodrich Brakes, the truck made the same run again, stopping almost *two and a half times* as fast.

For more information on how the B. F. Goodrich Hi-Torque Brake can help your equipment operate more safely, more dependably, write B. F. Goodrich Aviation Products, a division of the B. F. Goodrich Company, Troy, Ohio.

B.F.Goodrich Hi-Torque brakes

Exclusive P&H MAGNETORQUE® and ELECTRONIC CONTROLS put this 8 yd. P&H 1800 Electric Excavator far out in front for daily output in open pit mining operations.

This 2½ yd. P&H 955A is stripping overburden near Clarksburg, West Virginia. It is equipped with *exclusive* P&H MAGNETORQUE® *Electric Swing* which provides smoother, faster swings—without friction—without wear.

P&H Independent Planetary Boom Hoist contributes to the efficient operation of this 20-ton P&H 255A-TC. Boom lowering is always done under power in handling materials at this mine siding in McDowell County, West Virginia.

P&H

serves these open-pit mining needs

stripping

digging

loading

in a wide range of capacities

THE P&H LINE:

Electric Excavators from 3½ through 10 cu. yd.
Power Excavators from ½ through 4 cu. yd.
Truck Cranes from 10 through 70 ton capacity

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Milwaukee 46, Wisconsin

SIMPLEX WIRE and CABLES

. . . in Mining and Quarrying Mining engineers everywhere who insist on first line quality are careful to specify Simplex-TIREX heavy-duty cables. The durability for which TIREX is famous results from curing and conditioning advanced compounds in a lead mold. This process, originated by Simplex in 1920, has never been surpassed.

. . . in Power and Lighting Simplex-ANHYDREX and ANHYDREX XX Insulated cables are designed for installation in any environment. They operate dependably in circuits requiring up to 35 Kv; permit conductor temperatures as high as 90°C. wet or dry; and can be supplied with any desired outer covering, including Simplex special heavy-duty Neoprene, Simplex PLASTEX, and round wire armor.

. . . in Railroading Railroad men rely heavily on Simplex cable for every wiring application, including Power, Control, Communication, Signal, Diesel Wire, Car Wire, and portables. This is especially true where Signal Cable is concerned. Their sense of responsibility both to the road and to the public demands that they use only the finest.

. . . in Industrial Construction Plant engineers are constantly seeking ways to improve the quality of their buildings while reducing their cost. Simplex-CONDEX interlocked armored cables have become increasingly popular in building construction because they eliminate the need for ducts or conduits and still provide unmatched safety during operation.

. . . in Maintenance The reliability, safety and efficiency of any portable electric tool depends on the integrity of its cord or cable. Simplex-TIREX portable cords and cables are practically indestructible when used to do the work for which they are designed. TIREX portable cables are also cured and conditioned in lead.

For Specific Product Data Write To—

Simplex WIRE & CABLE CO.

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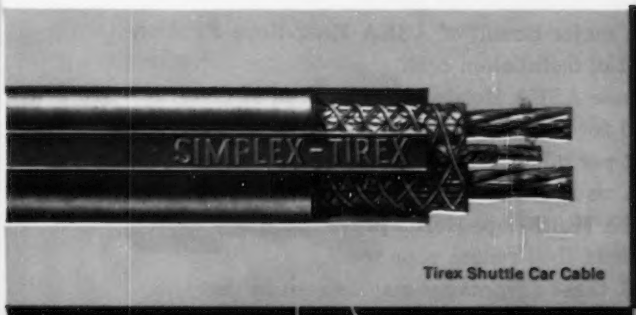
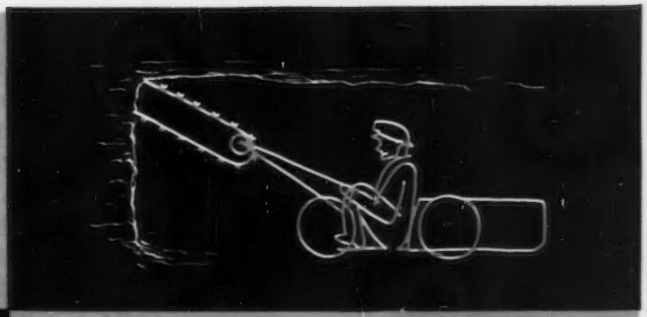
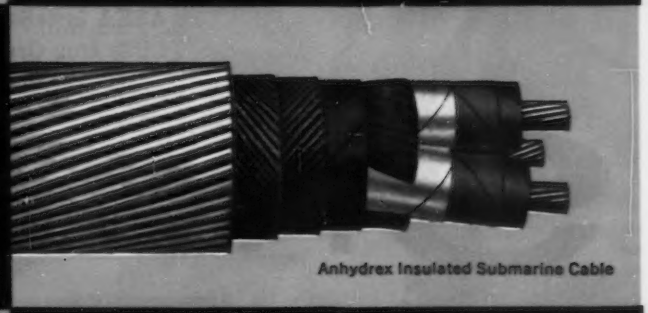
LIVE BETTER ELECTRICALLY

Engineered for Dependability

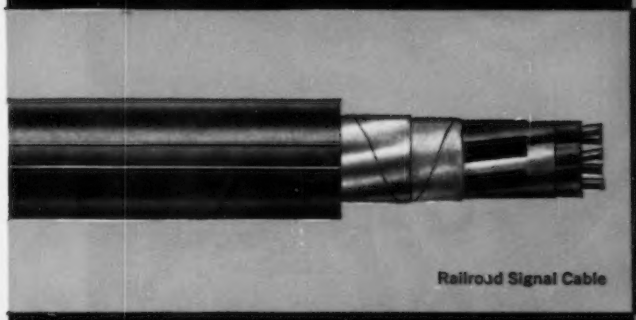


Tirex Shuttle Car Cable

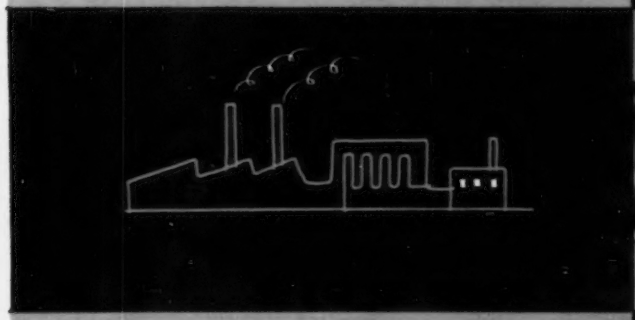


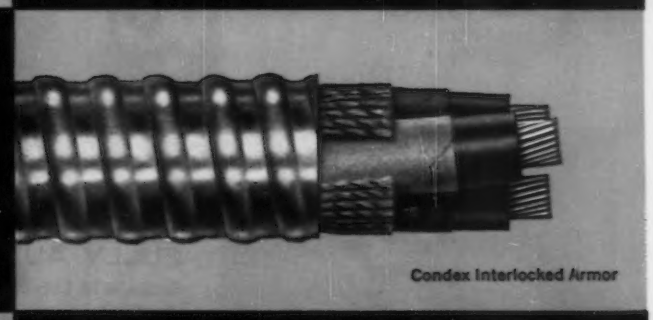


Anhydrex Insulated Submarine Cable



Railroad Signal Cable





Condex Interlocked Armor

Tirex Welding Cable

This impressive installation at Kiruna, Sweden, demonstrates a major benefit of ASEA Multi-Rope Friction Hoists: *low initial installation cost.*

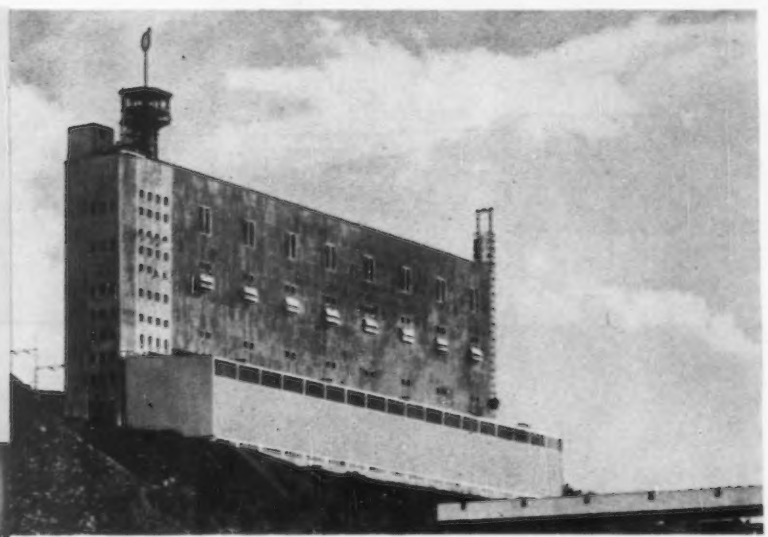
Each of these ASEA Hoists has a skipload of 22 tons and is designed for a depth of 1500 feet, maximum speed 2200 feet per minute.

At Kiruna, as in mining operations throughout the world, ASEA Multi-Rope Hoists prove less costly to operate, safer, and they reduce rope wear.

In the U.S. these advantages may be seen in the ASEA installations of National Potash Co. and Cleveland Cliffs Iron Ore Co.

9 HOISTS IN ONE HEAD FRAME

Total capacity: 4600 tons per hour



FULLY AUTOMATIC, the ASEA Hoists at Kiruna eliminate the employment of hoist men.
At U.S. wage rates, assuming two-shift operation, this would mean a saving of about $30,000 yearly for each hoist!

Write for illustrated literature on ASEA Multi-Rope Friction-Drive Mine Hoists.

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World pioneer in electrical products for industry

U. S. Sales and Service:

ASEA ELECTRIC, INC.
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EE PRODUCTS DO THE JOB BETTER AT LOWER COST!

Krebs Cyclone

Model EE20-9 integral two stage. Patented.

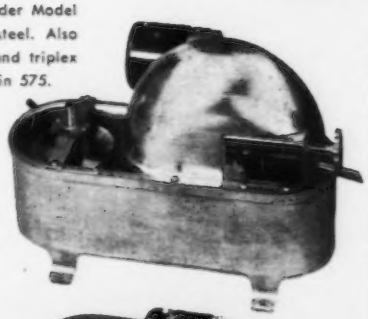
Krebs Cyclones with long sweep inlet for better performance and capacity at lower psi. Molded replaceable pure gum rubber parts throughout. Adjustable apex valves for all sizes. Write for Bulletin 830.

Krebs Cyclone

Model D20B single stage.

EE PRODUCTS

Clarkson Reagent Feeder Model E in 18-8 stainless steel. Also available in duplex and triplex units. Write for Bulletin 575.



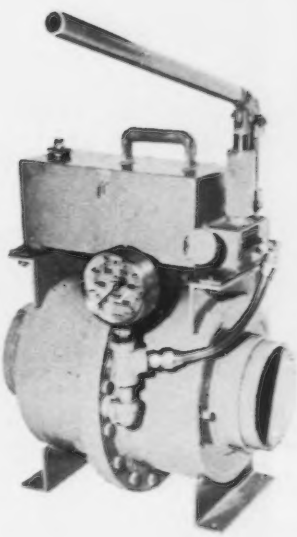
Clarkson Reagent Feeders

The standard for precise and low cost feeding of reagents throughout the world.

Clarkson Reagent Feeder Model E in PVC for acids. Write for Bulletin 584.

Clarkson Valve

The round hole, center flow makes it the most efficient valve for flow control. Hydraulically operated — remote if desired. Quickly responsive control. Write for data.



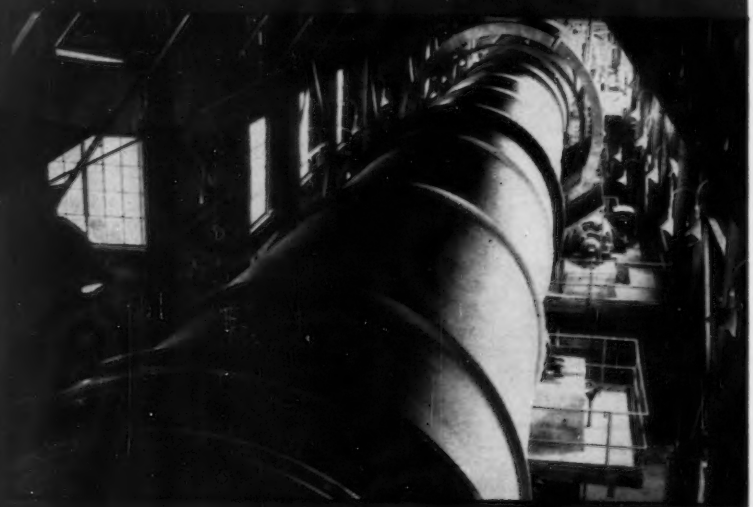
EQUIPMENT ENGINEERS INC.

41 SUTTER STREET SAN FRANCISCO 4, CALIFORNIA

SMIDTH

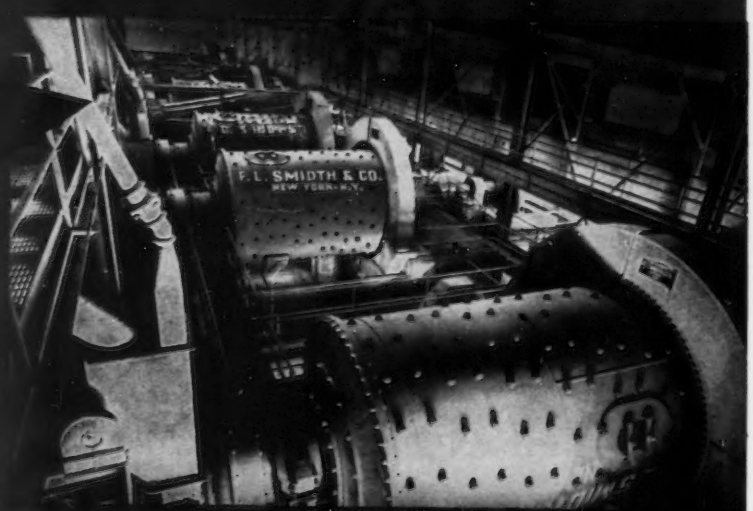
Rotary Kilns

For sintering, nodulizing, calcining, desulphurizing, oxidizing and reducing roasting—coolers, precoolers, preheaters, recuperators—and auxiliary equipment.



Grinding Mills

Ball mills, tube mills and multicompartment mills—open or closed circuit—wet or dry grinding also airswept for grinding and drying.



Over 1,000 Smidth Rotary Kilns and over 5,000 Grinding Mills supplied all over the world.

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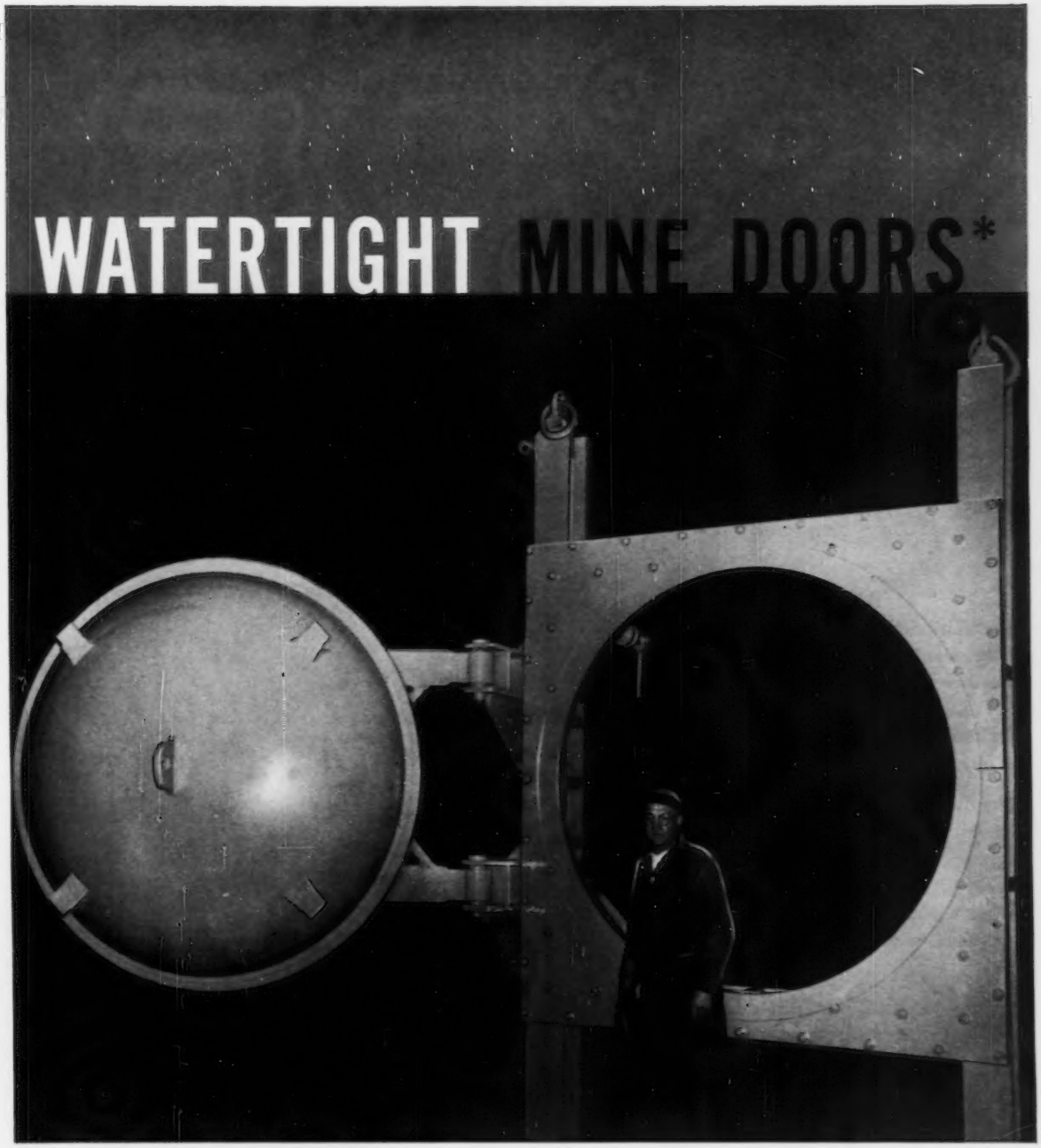
F. L. Smidth & Co. (Bombay) Private Ltd.
42 Queen's Road
Bombay, India

WATERTIGHT MINE DOORS*



Modern construction—superior to any previous mine closure. Simple one-man operation. No bolts or special tools. Closes and seals against water pressure. No space problem when open. Economical to install. Doors now installed in New Jersey Zinc Company mines for 78 to 108″ openings and for pressure to 770# per square inch. Other sizes now on order.

Inquiries directed to our Sales Engineering Department will receive prompt attention.

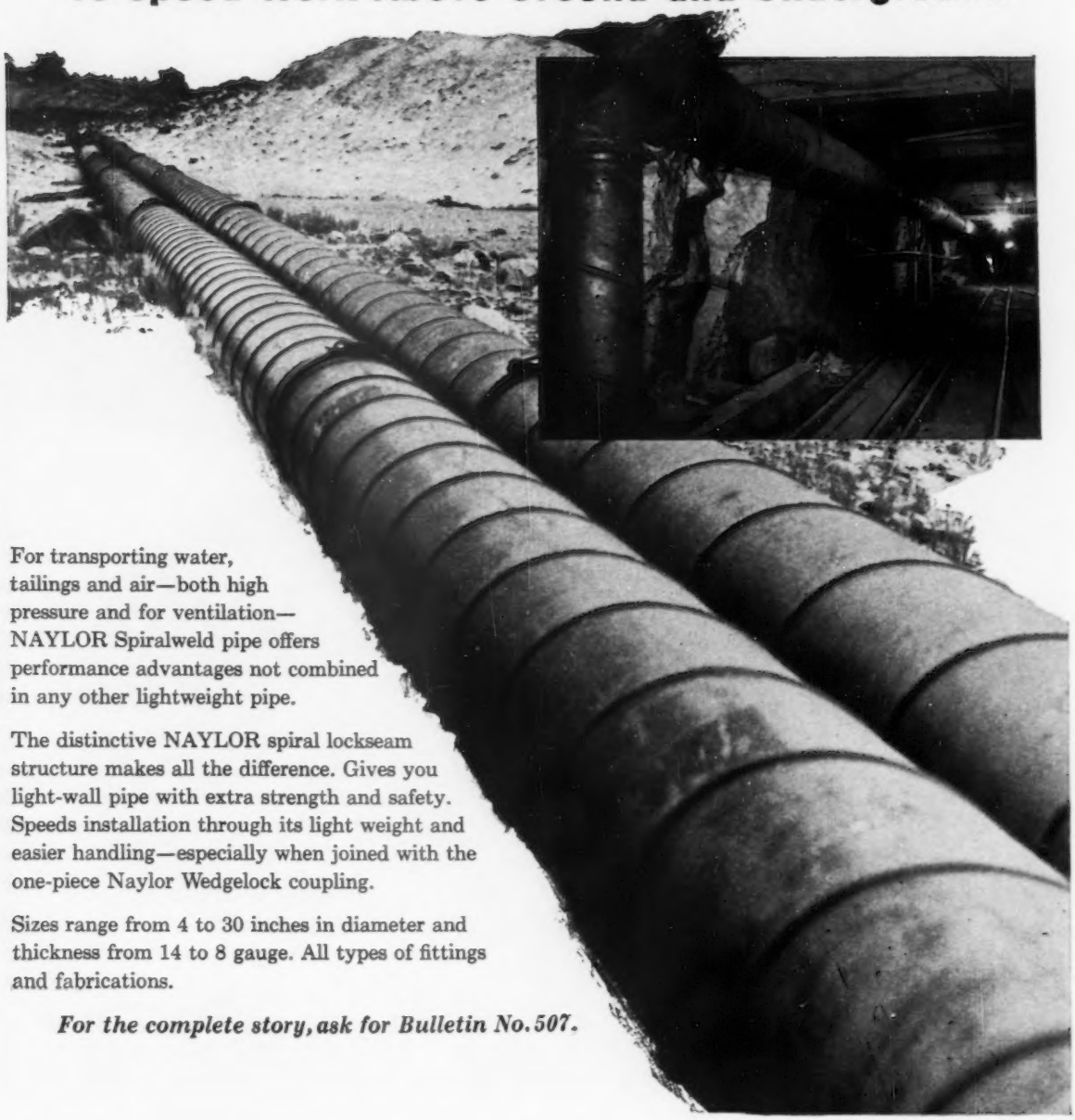
*"Patent Pending"

SUN SHIP

BUILDING & DRYDOCK CO.
CHESTER, PENNSYLVANIA

LOW-COST TRANSPORTATION SYSTEM

To Speed Work Above Ground and Underground



For transporting water, tailings and air—both high pressure and for ventilation—NAYLOR Spiralweld pipe offers performance advantages not combined in any other lightweight pipe.

The distinctive NAYLOR spiral lockseam structure makes all the difference. Gives you light-wall pipe with extra strength and safety. Speeds installation through its light weight and easier handling—especially when joined with the one-piece Naylor Wedgelock coupling.

Sizes range from 4 to 30 inches in diameter and thickness from 14 to 8 gauge. All types of fittings and fabrications.

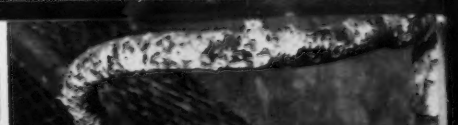
For the complete story, ask for Bulletin No. 507.

NAYLOR

NAYLOR PIPE COMPANY

1243 East 92nd Street, Chicago 19, Illinois

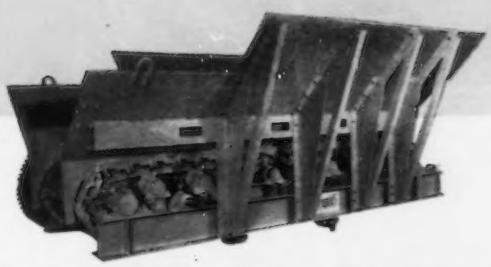
Eastern U.S. and Foreign Sales Office
60 East 42nd Street, New York 17, N. Y.



Cedarapids
Built by IOWA

HEAVY-DUTY EQUIPMENT FOR CUTTING PROCESSING COSTS

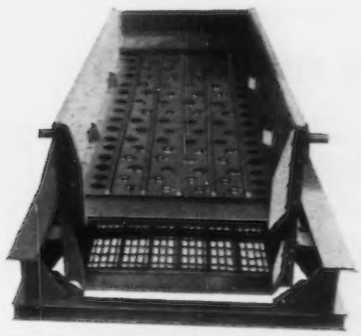
Cedarapids equipment is engineered with all the features essential to low-cost ore handling. Each unit is built for the *extra strength* necessary for heavy-duty service in the world's most rugged industry. Each unit is designed by experts in the field for *high capacity* production. The "proved-in-service" *low maintenance* costs of Cedarapids equipment is another bonus feature that helps you cut processing costs. Investigate Cedarapids advantages today!



HEAVY-DUTY APRON FEEDERS

ASSURE SMOOTH, WORKABLE FLOW OF ORE

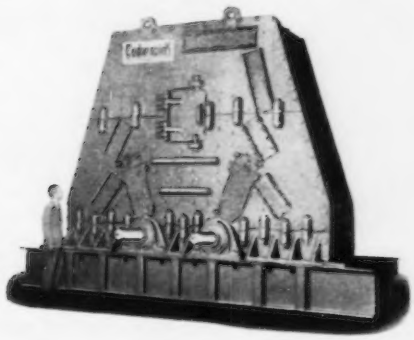
This big 40" x 12'4½" Apron Feeder is especially designed for smooth feeding of heavy, large-size material. Rugged construction, with 9 shafts beneath the heavy cast steel flights, withstands the dumping of heavy loads into the feeder.



HEAVY-DUTY SCALPING SCREENS

COMBINE BIG-VOLUME PRODUCTION WITH LOW MAINTENANCE COSTS

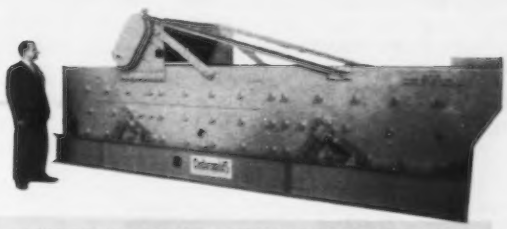
Cedarapids Inclined Double Deck Vibrating Screens are sturdily built to handle 2 to 3-ft. material. Eccentric shaft vibrating mechanism provides positive circle throw to assure big-volume output. Easily replaceable plate feed box and discharge lip reduce maintenance costs.



DOUBLE IMPELLER IMPACT BREAKERS

FOR PRIMARY AND SECONDARY CRUSHING IN ONE OPERATION

Double Impeller Impact Breakers are being used for more and more mining applications because of their exceptionally high output, design which permits a high percentage of material to be broken in suspension to minimize wear and reduce power requirements and the high reduction ratios which eliminate the need for secondary crushers in many instances. It will pay you to investigate all the many other advantages of Double Impeller Impact Breakers.



HORIZONTAL VIBRATING SCREENS

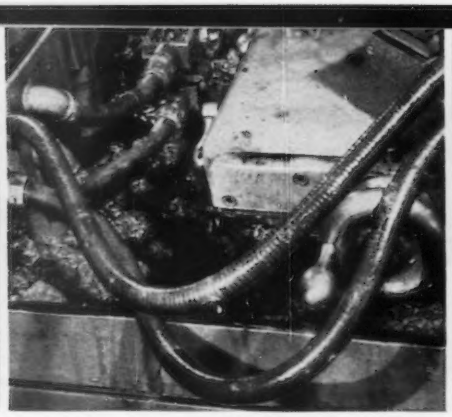
GIVE ACCURATE GRADATION—MAXIMUM CAPACITY

Many screen deck arrangements of Cedarapids Double and Triple Deck Screens in sizes up to 60" x 16' will give accurate gradation and maximum capacity for mining operations. Special underslung drive arrangements are available for applications where the headroom is limited or large oversize is encountered.

See your nearest Cedarapids Distributor for complete details

IOWA MANUFACTURING COMPANY
Cedar Rapids, Iowa, U.S.A.

Sealtite resists corrosive mixture of powdered calcium sulphate, magnesium oxide and magnesium chloride.

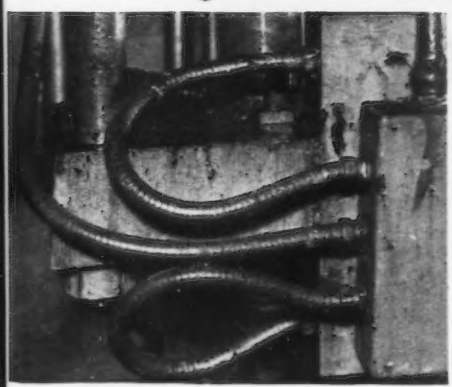


Sealtite protects grinder motor leads . . . flexes continuously under abrasive coat of metal dust, oil and coolant.

In paper mill's steamy air, Sealtite is covered with oil and wet pulp containing chlorine and caustic soda.

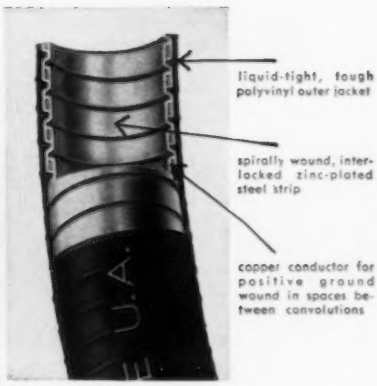
Give the dirtiest jobs to

SEALTITE flexible, liquid-tight conduit



Sealtite makes tight bends on hydraulic press, keeps motor leads free from oil, grease and water.

Sealtite keeps weather out of leads to outdoor pump motor.


liquid-tight, tough polyvinyl outer jacket
spirally wound, interlocked zinc-plated steel strip
copper conductor for positive ground wound in spaces between convolutions

Cutaway shows construction details of Sealtite Type UA.

TYPE U.A.— TYPE C.S.A. Specifications for Type U. A. (Underwriters' Laboratories Approved) and Type C. S. A. (Canadian Standards Association Approved). Construction: flexible galvanized steel core, positive ground and tough extruded outer cover.

TRADE SIZE	INSIDE DIAMETER		OUTSIDE DIAMETER		APPR. INSIDE BEND DIAM.	EST. WGT. (Lbs. Per 100 Feet)
(Ins.)	Min.	Max.	Min.	Max.		
3/8	.484	.504	.690	.710	6	30.0
1/2	.622	.642	.820	.840	7	36.6
3/4	.820	.840	1.030	1.050	10	48.2
1	1.041	1.066	1.290	1.315	12	87.7
1 1/4	1.380	1.410	1.630	1.660	15	116.5

TYPE E. F. † (Extra Flexible)—for machine tools and industrial equipment. (Meets standards set by J.I.C.)

TRADE SIZE	INSIDE DIAMETER		OUTSIDE DIAMETER		APPR. INSIDE BEND DIAM.	EST. WGT. (Lbs. Per 100 Feet)
(Ins.)	Min.	Max.	Min.	Max.		
3/8	.485	.500	.695	.710	5	24
1/2	.620	.635	.825	.840	5	29
3/4	.815	.830	1.035	1.050	6	39
1	1.030	1.050	1.295	1.315	8	67
1 1/4	1.370	1.390	1.635	1.660	10	87
1 1/2	1.575	1.595	1.875	1.900	12	105
2	2.020	2.040	2.350	2.375	15	135
2 1/2	2.480	2.505	2.850	2.875	20	198
3	3.070	3.100	3.470	3.500	26	282
4	4.000	4.040	4.460	4.500	34	414

Commercial tolerances apply on above figures.

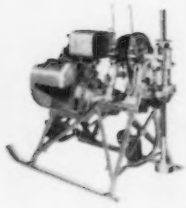
†Pat. Applied For

Sealtite flexible, liquid-tight conduit gives wiring maximum protection against oil, grease, water, dirt, chemicals, corrosive atmospheres and weather. Nothing gets through its tough, polyvinyl outer covering. It stands up under continuous flexing . . . absorbs vibration, connects moving parts . . . connects misaligned outlets . . . prevents burn-outs. For long runs or short leads it's easy to install . . . saves the time it would take you to cut, bend and fit rigid conduit.

ELECTRICAL WHOLESALERS stock Sealtite in cartons or on non-returnable wooden reels. Buy it in long lengths . . . cut it on the job without waste. Your electrical wholesaler also stocks liquid-tight connectors. For more information write for Sealtite bulletins. Address *The American Brass Company, American Metal Hose Division, Waterbury 20, Conn.* 55162 Rev.

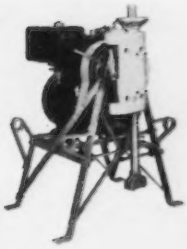
SEALTITE® FLEXIBLE, LIQUID-TIGHT CONDUIT

AN **ANACONDA®** PRODUCT



BBS-1

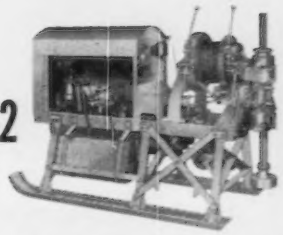
World's best known surface drill. Handles "E" Rods to 1,500 ft., "A" to 1,100 ft.



x-ray

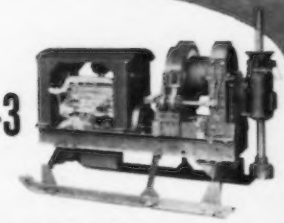
Compact, portable—185 lbs. net. Takes ¾" or ⅝" core to 200 ft. Low fuel consumption.

BBS-2



Versatile, choice of 5 swivelheads. Depths to 3,500 ft. Gas or diesel.

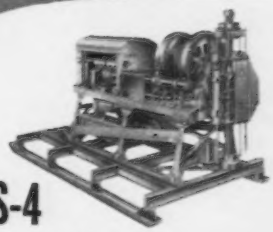
BBS-3



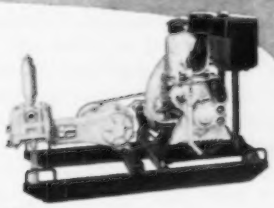
Strong, speedy unit for deep drilling . . . 4,600 ft. with "A" or "B" Rods, 95 h.p. diesel.

if it's for diamond drilling we make it!

BBS-4



Drills to 5,000 ft. with "B" Rods. Moves under own power, gas or diesel.



drill pumps

5-12 and 4-7 models. Capacities 400 to 1,200 g.p.h. Diesel motor optional.

permaset bits

(Powdered metal)

All standard sizes available from stock. Also reaming shells, etc.

bazooka

Portable. One man sets up in stopes or raises without mining bar or sprags. Capacity 200 feet with "E" Rods.

JV

4 feed swivelhead. Capacity 800 ft. with "E" Rods. JVR with right-hand feed screw for blastholes.

BBU-2

Rugged. Capacity 1,800 ft. with "E" Rods, 1,400 ft. with "A", four gear speeds.

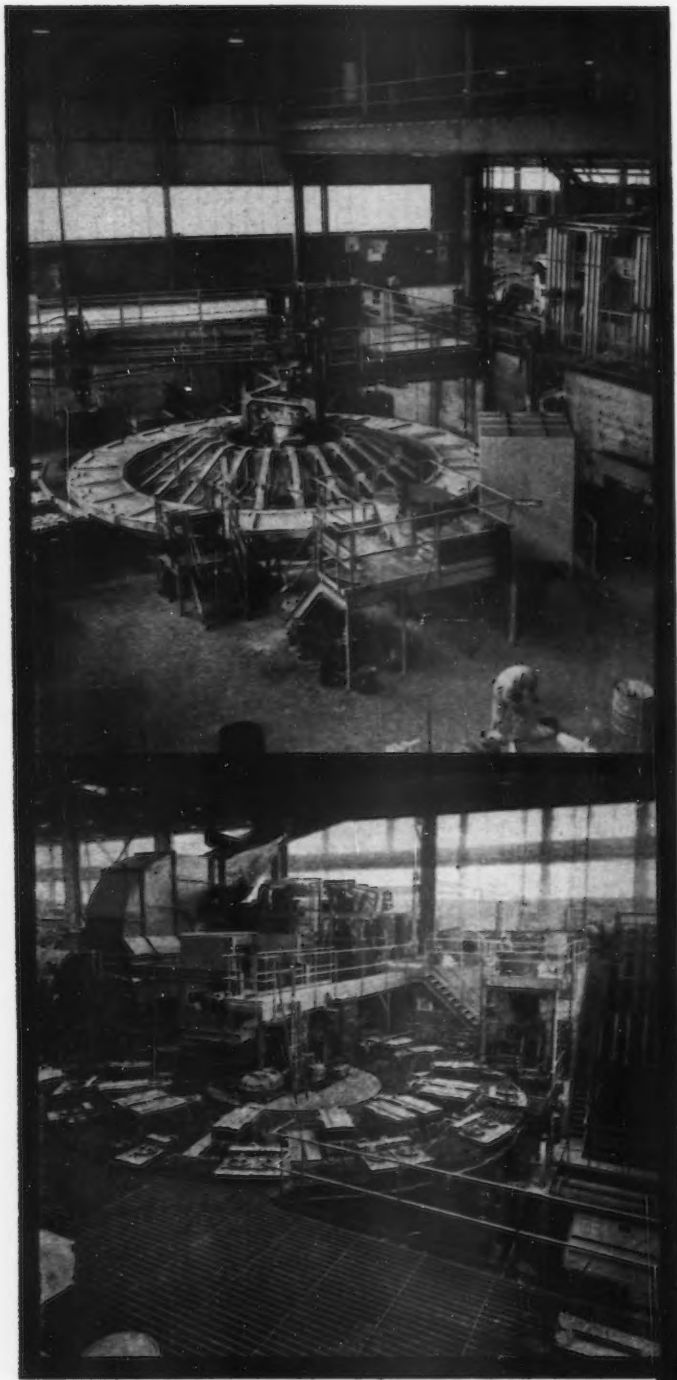
VEG

Vane motored version of J.V. Lightweight, compact construction. Can be speedily dismantled into two units.

58-5

BOYLES BROS
DRILLING COMPANY LTD.
VANCOUVER, CANADA

BOYLES BROS. DRILLING CO. LTD., NEWCASTLE-ON-TYNE, ENGLAND • BOYLES BROS. (PTY.) LTD., JOHANNESBURG, SOUTH AFRICA
BOYLES BROS. (PTY.) LTD., KITWE, NORTHERN RHODESIA • ATLANTIC, GULF & PACIFIC COMPANY OF MANILA, MANILA, PHILIPPINES
DR. ALBERTO BIANCHI, MILANO, ITALY • CIA. "DIAMANTINA B.H." S.A., LIMA, PERU • DIMITRY SCALISTIRI, ATHENS, GREECE
FORMAC S.A., RIO DE JANEIRO, BRAZIL • HAEHRE AND COMPANY, A/S, OSLO, NORWAY • ITEC, S.R.L., BUENOS AIRES, ARGENTINA
JOHANSSON & CIA., S.A., LA PAZ, BOLIVIA • SHRIRO TRADING COMPANY S.A., TOKYO, JAPAN • TRILLIANCE ENGINEERING CO., BOMBAY, INDIA • WIESE AND CA. LDA., LISBON, PORTUGAL.



HOW

can trim your

Today, many producers of copper, aluminum and other metals are effecting important economies in manpower costs — *through automation of casting and handling equipment.* We know, because, for a large percentage of the most modern installations, Treadwell has prepared the layout, handled the engineering, and built and installed the equipment.

This same experienced assistance is available to you. Here is how Treadwell can help you.

COPPER SMELTING AND REFINING

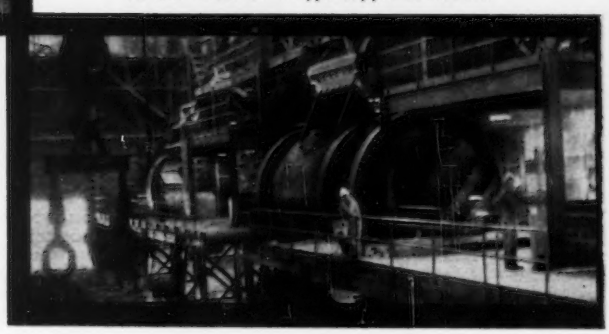
Wheels for casting anodes, cakes, billets, ingots, ingot bars and wire bars can be supplied for automatic-stop and manual-start operation, with push-button controlled pouring mechanism, and automatic knockout, conveying, spray-cooling, dressing and mold-making equipment. Automatic turnover mechanisms for cakes and billets, and automatic stackers for anodes, ingots, ingot bars and wire bars can also be furnished. Reverberatory, holding, and melting furnaces, converters, converter up-takes and steel flues, ladles and slag cars are designed to meet individual requirements and are carefully matched in capacity to assure efficient production.

In fact, Treadwell is prepared by experience to undertake complete "turnkey jobs"—including production layout, design and erection of buildings and other structures, fur-

Top photo—Wheel for casting copper anodes, furnished by Treadwell, with remotely controlled pouring mechanism, automatic knockout mechanism and anode take-off crane. Cooling, dressing and mold-making equipment also designed and supplied by the company.

Above—38-foot combination casting machine for vertical casting of copper cakes and billets. Shapes are dumped and cooled in the pit at the lower right. Elevating conveyor for delivering cakes to inspection floor is at the far right.

13'x30' Peirce Smith type copper converters.



AUTOMATION

costs in smelting and refining

nishing and installing all equipment and supervising start-up of the plant.

STRAIGHT-LINE ALUMINUM CASTING

Treadwell straight-line aluminum casting machines are built for high-speed, low-cost production. Ingots are poured, stamped, spray cooled and conveyed to a stacking machine—all automatically. The stacker nests the ingots, and places them in rows ready for pickup by a lift truck. The spray conveyor cools the ingots so they can be automatically banded as soon as they are stacked.

OTHER METALS AND ALLOYS

In addition to copper and aluminum, Treadwell has designed and built a wide variety of equipment for the production of other non-ferrous metals and alloys. These include lead, nickel, tin, brass, bronze and zinc, among others.

FOR FURTHER INFORMATION

For a preliminary discussion of your requirements, you name the time and place. A Treadwell sales engineer will be there. In the meantime, send for a copy of bulletin No. 70, which describes Treadwell equipment.

M. H. TREADWELL COMPANY, INC.
140 Cedar Street, New York 6, N. Y.
1015 Farmers Bank Bldg., Pittsburgh 22, Pa.
208 So. LaSalle St., Chicago 4, Ill.

TR-31

Straight-line aluminum casting machine with automatic stamping device and stacker. Wheels for casting aluminum cakes are also available.

Automatic stacker for aluminum billets.

225 cubic-foot slag car.

TREADWELL

Non-ferrous
Smelting and Refining
Equipment

CORES via COPTER

Boyles modern exploratory drilling eliminates time and cost of packing-in to inaccessible areas.

Boyles Bros. Drilling Co. has adapted tools and machines to a helicopter operation that gets drilling jobs set up in almost inaccessible areas in a fraction of the time required by conventional land operations. Illustrated is a drilling job, in a primitive area of the Pacific Northwest, that would have required three weeks to pack-in the necessary equipment. The crew and all the supplies, except timbers secured at the site, were transported to the job in record time by helicopter.

Since 1895 Boyles Bros. Drilling Co. has applied its engineering skill and fine equipment to the task of completing jobs as per agreement.

Write or call your nearest Boyles Bros. office for complete details on:
EXPLORATION and DEVELOPMENT
CORE DRILLING, SURFACE and UNDERGROUND
ROCK BREAKING — GROUTING
SHAFT SINKING — MINING
QUARRYING and TUNNEL DRIVING

Drilling horizontal hole underground.

Shaft sinking in uranium district.

Boyles Bros. DRILLING COMPANY

1321 South Main Street HUnter 7-7595 Salt Lake City, Utah

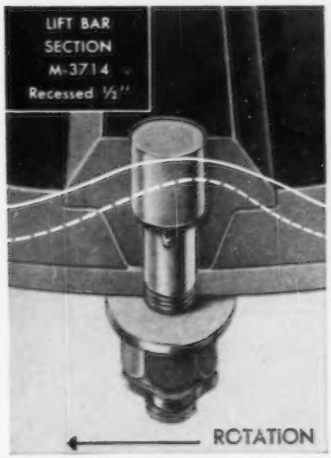
Spokane, Washington	WAlnut 4-2614	Reno, Nevada	FAirview 9-0732
Leadville, Colorado	1056	Denver, Colorado	WEst 4-0673
Phoenix, Arizona	CRestwood 4-5331	Alaska	Contact Salt Lake City Office

Four USS Rolled Plate Linings

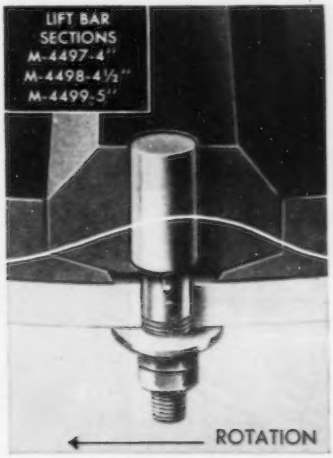
better 4 ways...

This type of low-cost lining is recommended for cement and soft grinding jobs. Plates are available in 1¼" and 1½" thicknesses. Bars are 6" wide—with 1⅝" lift. Ideal with balls up to 1¼" diameter. Line indicates maximum wear pattern.

Plates are available in 1½", 2", 2½" and 3" thicknesses. Bars are 7" wide—2½" lift. Designed for use with larger diameter balls up to 4". Line indicates maximum wear pattern.



Plates are available in 2", 2½" and 3" thicknesses. Bars are 7" wide. With the ½"-deep plate recesses, lift is 2". Because of the recessed design, bearing surface is retained permitting replacement of lift bars for extended service. Solid line indicates wear pattern with original bars. Dotted line indicates wear line of replacement bars.



Heavy duty linings and lift bars for toughest grinding assignments. Plates are available in 2", 2½" and 3" thicknesses. Bars are 8⅜" wide. Variable lifts from 1⅛" to 2½" are available. Line indicates maximum wear pattern.

These are the only linings made of hot rolled steel. Our bars and plates are special hot worked steel that is given superior toughness which eliminates breakage even when worn to paper thinness.

1. These are the only linings made of *hot rolled* steel. Our bars and plates are not castings, but are special hot worked steel, given superior toughness that eliminates breakage even when worn to paper thinness.

2. Lift bars are of rolled alloy steel with extra hardness and toughness that provides lift and better grinding efficiency throughout the life of the lining. For more severe service, bars are heat treated.

3. Lift bars and lining plates are made to exact dimensions for close tolerances that permit snug fit and eliminate shell wash—no zincing required.

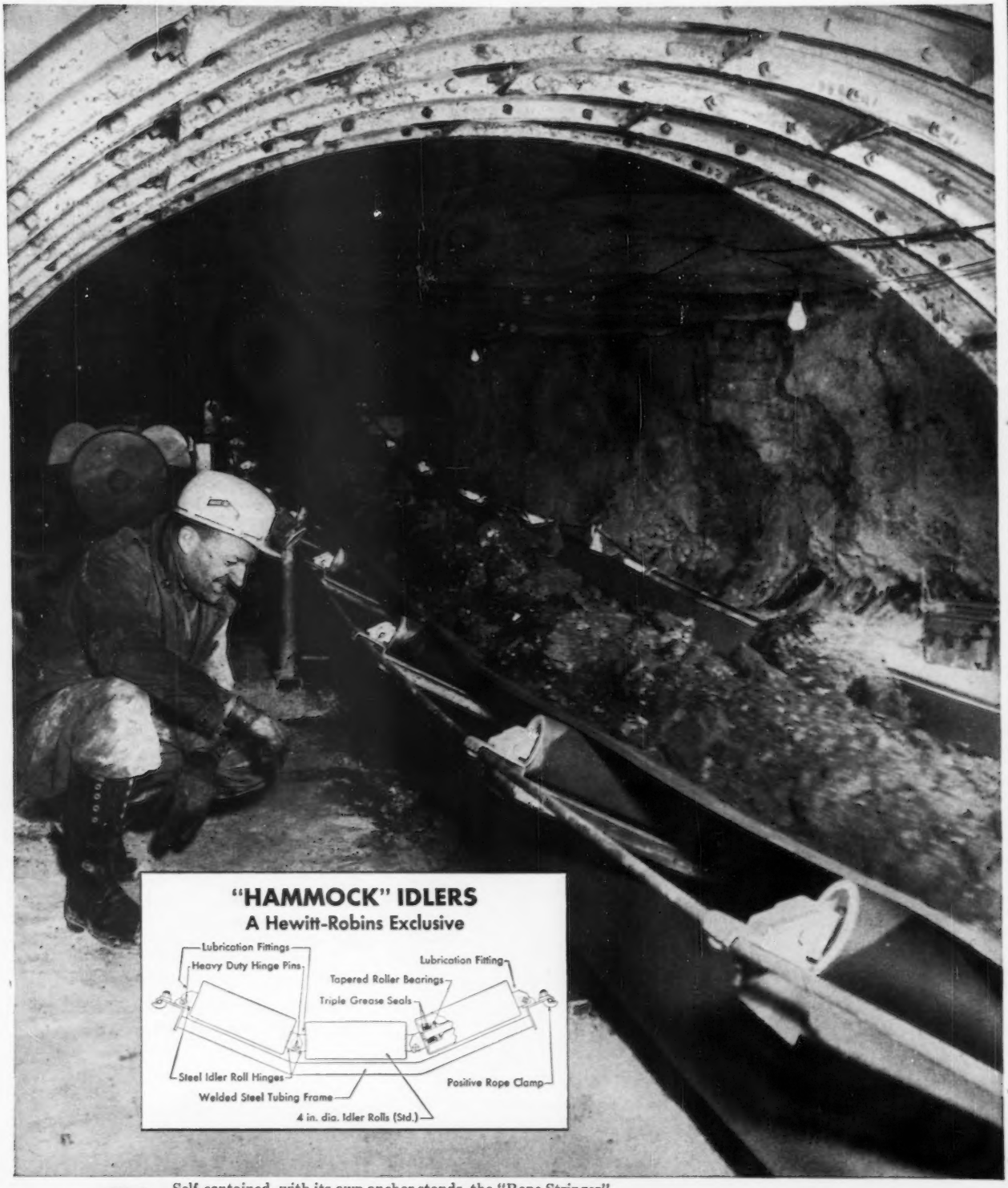
4. Better design, better materials – they permit the use of thinner linings, thus increasing mill capacity.

Call on us for expert technical assistance on any grinding problem.

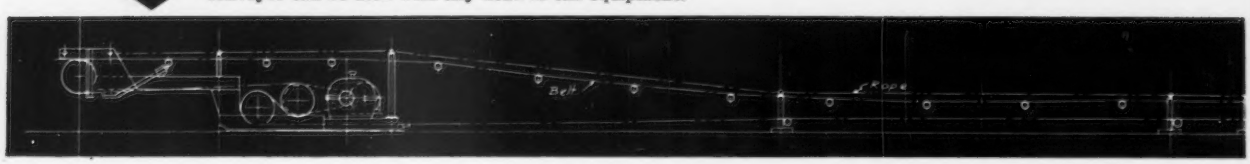
USS is a registered trademark

United States Steel Corporation – Pittsburgh
Columbia-Geneva Steel – San Francisco
Tennessee Coal & Iron – Fairfield, Alabama
United States Steel Export Company

USS United States Steel



Self-contained, with its own anchor stands, the "Rope Stringer" conveyor can be used with any head or tail equipment.



"ROPE STRINGER"

The last word in low-cost, high-capacity, easy-to-handle conveyors

See how Hewitt-Robins has made the "Rope Stringer" conveyor easy to handle, economical to buy, simple to install and operate!

The "Rope Stringer" conveyor consists of simple support and anchor stands, the supporting wire ropes, Hewitt-Robins exclusive "Hammock" idlers, and Hewitt-Robins conveyor belt. The conveyor can be extended by a small crew and can be dismantled and set up in a new location in a fraction of the time required by rigid conveyors!

With this "Rope Stringer" conveyor, spillage is greatly reduced. Thanks to the catenary action of the "Hammock" idlers, spillage is less than one third that of a rigid deck conveyor. And safety is increased, too—the "Hammock" idler and frame assembly can be quickly removed or replaced as a unit, with the belt in place!

"Rope Stringer" Conveyor Advantages

Valuable features incorporated into this new Hewitt-Robins rope conveyor are made possible by the use of flexible supports and a unique "Hammock" idler arrangement. These give several major advantages:

Easy Installation

- Idlers are quickly skidded into position between belt strands.
- Trougher spacing is readily varied to suit conditions.
- Anchor stand assemblies can be bottom or roof mounted.

Better Operation

- Minimum spillage—load and belt are continuously centered by catenary action of hinged "Hammock" idlers.
- Longer belt life through cushioning action of "Hammock" idlers.
- Rounded idler frame protects return belt at points of severe dip.
- No training idlers required.
- Level travel assured because either leg of stand can be adjusted for height.

Provision for Relubrication

- Triple-sealed bearings can be easily relubricated.

Simple, Sturdy Construction

- Strong, welded tube spreader frame.
- Substantial, long-life link and hinge design idler rolls.
- 4, 5, or 6 in. idler rolls available.
- Removable link pin for idler roll replacement.

Maximum Safety

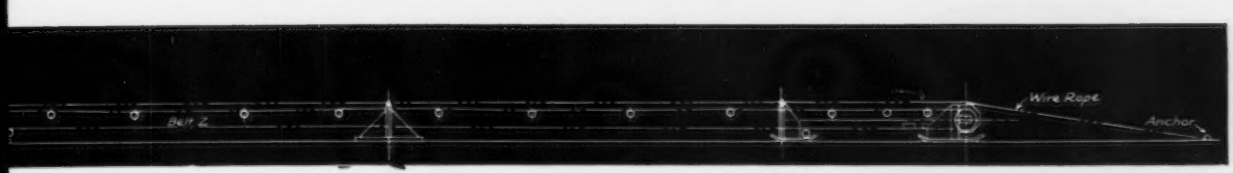
- Idler rolls and frame positioned as a unit.
- Double spreader prevents idler rolls from dropping onto return belt.

See for yourself how this new "Rope Stringer" conveyor can pay for itself promptly in *your* operations! Only Hewitt-Robins provides all the advantages of the "Rope Stringer" conveyor—*complete* with the H-R belt of your choice! For further details, consult your Hewitt-Robins representative.

HEWITT-ROBINS

THE NAME THAT MEANS EVERYTHING IN BULK MATERIALS HANDLING SYSTEMS...

CONVEYOR BELTING AND IDLERS • POWER TRANSMISSION DRIVES • INDUSTRIAL HOSE • VIBRATING CONVEYORS, SCREENS & SHAKEOUTS

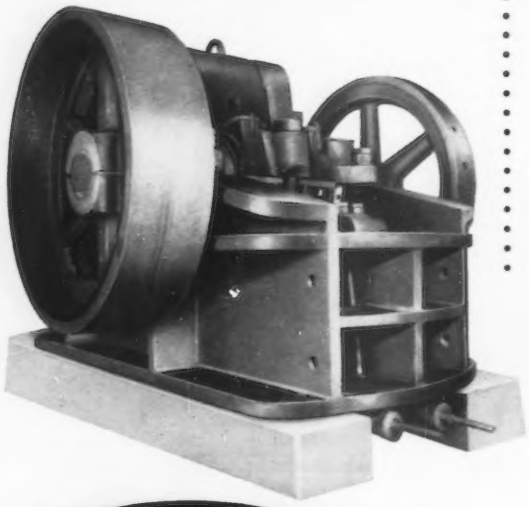


Traylor - MADE MACHINERY

SOLVES YOUR CRUSHING PROBLEMS

Gyratory Crushers

Traylor manufactures three types of Gyratory Crushers—TC for large capacity, TY for secondary, and TF for fine reduction. The TC Crusher is built in six sizes with capacities ranging from 245 tons of a 2″ product to 4,100 tons of an 11″ product. Type TY is also made in six sizes from 1′ 3″ to 5′ 6″ with feed openings from 3″ to 22″. Type TF Fine Reduction Crusher is made in four sizes for operators whose needs demand economic production of 5/16″ to 1¼″ material in large capacity. All of these crushers feature the Traylor original non-choking, bell head and curved concaves. For detailed information and description, write for Bulletins—TC—No. 1126; TY—No. 8112; and TF No. 127.



Jaw Crushers

Traylor Jaw Crushers are built in five types with 17 different size feed openings. Capacities range from 4 tons of 7/8″ material to 1,000 tons of 11″ material per hour. Traylor's patented swing jaw suspension and originally developed curved jaw plates account for greater capacity at finer settings and longer life of jaw plates. For detailed information, ask for Traylor Bulletins—H—No. 6105; R—No. 1123; S—No. 125; HB—No. 104; M—No. 1124.

Traylor

TRAYLOR ENGINEERING & MFG. CO. 1061 MILL ST., ALLENTOWN, PA.

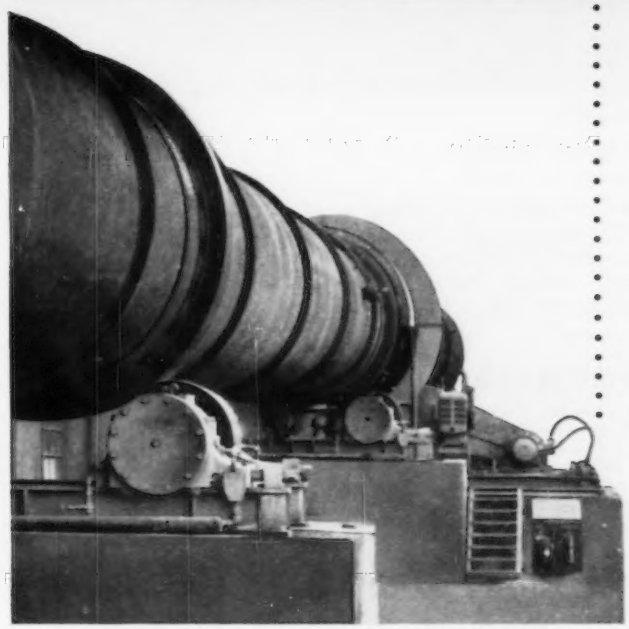
Sales Offices: New York — Chicago — San Francisco

Canadian Mfr.: Canadian Vickers, Ltd., Montreal, P. Q.

INCREASES PRODUCTION!

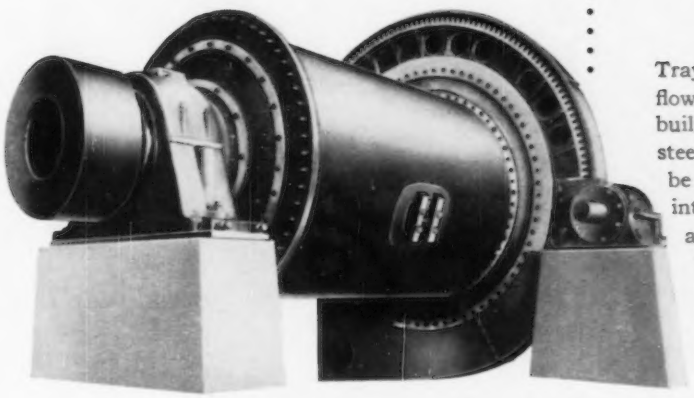
INCREASES PROFITS!

Over a half a century of engineering experience is built into Traylor-MADE machinery



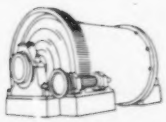
Rotary Kilns

Traylor Rotary Kilns feature the most advanced and sound design and rugged dependability for which Traylor engineers are known. Only quality steel plate is used in the fabrication of Traylor Kiln Shells with all joints automatically welded. All Traylor Kilns have the full-floating type of tire with special mounting holding the tire securely in place but permitting it to float free of the shell as it contracts and expands. Other outstanding features of Traylor Rotary Kilns are the drives which are mounted on an adjustable base. The gear train has high and low addendum machine-generated teeth of heavy proportions for long life. For details, write for Traylor Bulletin No. 1115.

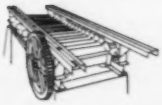


Ball Mills

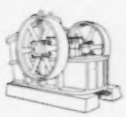
Traylor Ball Mills are made in three types—overflow, diaphragm or peripheral discharge. They are built for either wet or dry grinding. Shells are of steel plate, automatically welded. Shell liners can be furnished in various types. Trunnions are cast integrally with the detachable heads. Driving gears are steel precision cut on our Maag gear generator. Traylor grinding mills are available in Ball, Rod, Compartment, Tube and Pebble Mills. Write for Bulletin No. 11-121.


BALL MILLS

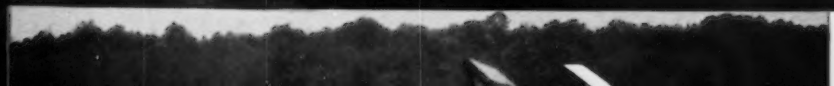
ROTARY KILNS


APRON FEEDERS

PRIMARY GYRATORY CRUSHERS


JAW CRUSHERS

SECONDARY GYRATORY CRUSHERS



Over-the-edge-dump

Operator of LeTourneau-Westinghouse Rear-

AERO FINDS ORE

New Electromagnetic Detector helps uncover deposits in speedy treetop level surveys

AERO's latest airborne exploration tool now supplements reconnaissance surveys with accurate, low-level, detailed work so precise that often little or no ground follow-up is needed.

The AERO/Newmont Electromagnetic Detector, mounted in our helicopter together with Airborne Magnetometer and Scintillation Counter, provides complete coverage regardless of rugged terrain.

The ratio of the in-phase response to the out-of-phase response in the new Electromagnetic Detector gives a valid indication of the relative conductivity of the anomalous zones. Surveys in northern New Brunswick, for example, showed that it is relatively easy to separate graphitic zones from massive sulphides. The out-of-phase response was very marked over both graphites and massive sulphides. The in-phase response, however, was zero over the graphites and very pronounced over the massive sulphides.

SEND FOR UNEDITED COPIES OF FIELD RECORDS

On request, we will be glad to send you our brochure containing unedited copies of our original field records from the New Brunswick surveys. Write for "*Detailed, Low Level Prospecting*" today.

AERO SERVICE CORPORATION

Oldest Flying Corporation in the World

Philadelphia 20, Pa.

AIRBORNE GEOPHYSICAL STUDIES • PRECISE AERIAL MOSAICS • TOPOGRAPHIC MAPS • PHOTO INTERPRETATION • RELIEF MODELS

BALL MILLS ROTARY KILNS APRON FEEDERS PRIMARY GYRATORY CRUSHERS JAW CRUSHERS SECONDARY GYRATORY CRUSHERS

Over-the-edge-dump

Operator of LeTourneau-Westinghouse Rear-Dump can dump accurately and safely over edge of hopper or spoil pile because of machine's front-wheel drive, independent braking, and electric-controlled bowl. To dump, operator backs close to edge, sets brakes on rear wheels, leaving front wheels unbraked. He then flicks switch to instantly activate electric bowl-hoist motor. As bowl rises, it pulls prime-mover back, shortening wheelbase. Bowl swings deep behind rear wheels, stops roll-back of material . . . casts it out and away. Drive wheels of prime-mover always stay on firm footing, for fast getaway in case bank begins to cave in.

COMPARE

- capabilities of your present haulers
- advantages of L-W Rear-Dumps

Hauls through soft, slippery areas

L-W Rear-Dumps haul safely through areas where other units bog down. Here's why: (1) Exclusive power-transfer differential, automatically transfers power from a slipping drive wheel to wheel on better footing. (2) 90° kingpin electric steer . . . independent of drive train . . . helps you "duck walk" out of trouble. Operator just turns prime-mover left, right, left, etc., to swing drive wheels ahead until they "walk" out and reach solid footing. (3) Rear-Dump can be "humped" forward, when bowl is empty, to get out of soft areas. Bowl is raised with front brakes locked and rear brakes released, shortening wheelbase . . . then bowl is lowered with rear brakes held and front released. Thus, without use of drive wheels, Rear-Dump "humps" forward.

No-drag "skid bottom" construction

There are no springs, hangers, tie-rods cluttering up the bottom of your L-W Rear-Dump. Simple "skid bottom" construction eliminates drag over dirt and rocks. Bowl is hitched to prime-mover through a horizontal yoke extending back from kingpin, and pivoted to body itself . . . just above and ahead of rear wheels. There is no frame or sub-frame to get out of alignment. Front-wheel drive and kingpin steer eliminate long drive shaft, hinged steering connections.

Big target for fast, easy loading

L-W Rear-Dumps' big, wide, unobstructed top makes an easy target for your shovel operators. Low, wide rear entry of this hauler lets dipper swing in smoothly, quickly . . . in one continuous arc . . . rather than the up-over-in, up-over-out motions needed with high-top trucks.

Big, single tires absorb shock, eliminate trouble of duals

4 giant, low-pressure tires dissipate vibrations and stress of high-speed hauls . . . absorb shock of heavy loads dropped into bowl. They flex and roll easily over rocks that might bruise or break smaller duals. There is no divided face where wedged-in rock fragments can wear and tear.

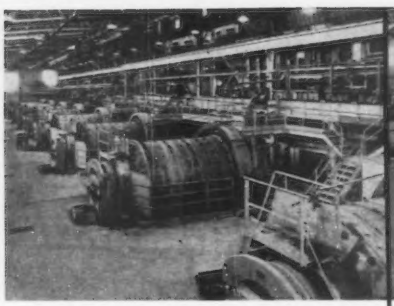
Write or phone your local L-W Distributor for more information on these big-production, low-cost Rear-Dumps. They are available in 11, 22, and 35-ton sizes.

R-1871-MQ-1

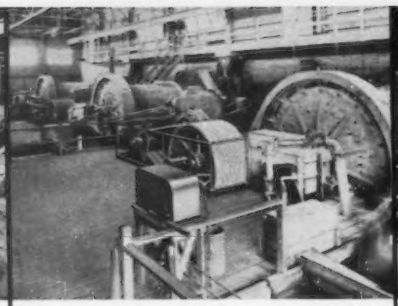
LeTOURNEAU-WESTINGHOUSE COMPANY, PEORIA, ILLINOIS

A Subsidiary of Westinghouse Air Brake Company

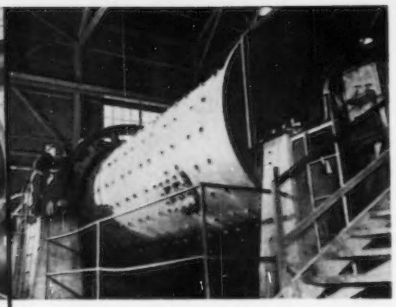
Where quality is a habit



This large copper company has 17, 9½'x 12' and three 10'x 14' Marcy Open End Rod Mills; three 8'x 12' and three 10'x 12' Marcy Grate Discharge Ball Mills.



Three 8'x 9' Marcy Grate Discharge Ball Mills in a large copper mill.

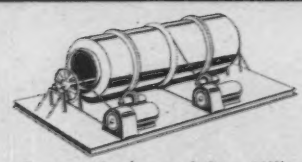


This 8'x 20' Marcy Pebble Mill is one of 21 Marcy Mills used by a molybdenum company.

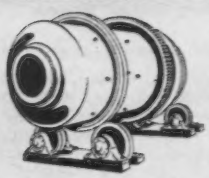
Marcy Grinding Mills

- grate discharge ball mills, open end rod mills, tube mills, pebble mills, center and end peripheral discharge rod mills, acid-proof mills, batch mills.
- for metallic and non-metallic ores, cement, specification sands, clay, fibrous material.
- wet or dry grinding.
- 29 different diameter sizes, from 12" to 12'6" inside diameter, are operating and proved in the field.
- grind material 1½" or finer to a product as fine as 325 mesh.
- capacities up to 6650 tons per 24 hours.

Other Products

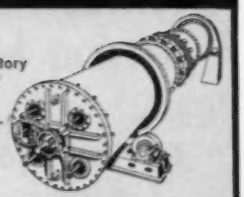


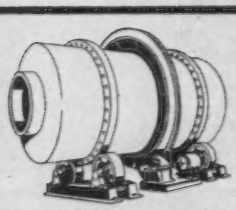
Custom Engineered Pug Mills.



Custom Engineered Leaching Drums.

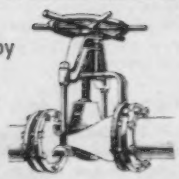
Burt Filters.
30"x 72" Laboratory Unit, and 5'x 40' Standard Commercial Size.

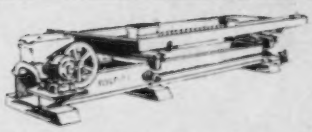




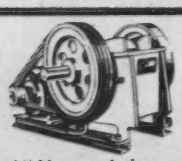
Custom Engineered Fusion Furnace.

Massco-Grigsby Pinch Valves.
1" to 14" dia.

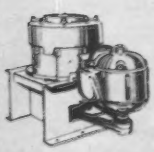




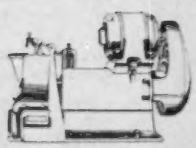
Wilfley Concentrating Tables.
Laboratory and Commercial Sizes.



4"x 6" Massco Laboratory Jaw Crusher.



6" and 10" Massco Gy-Roll Reduction Crusher.



Massco-McCool Pulverizer.

Marcy Direct Reading Pulp Density Scale.

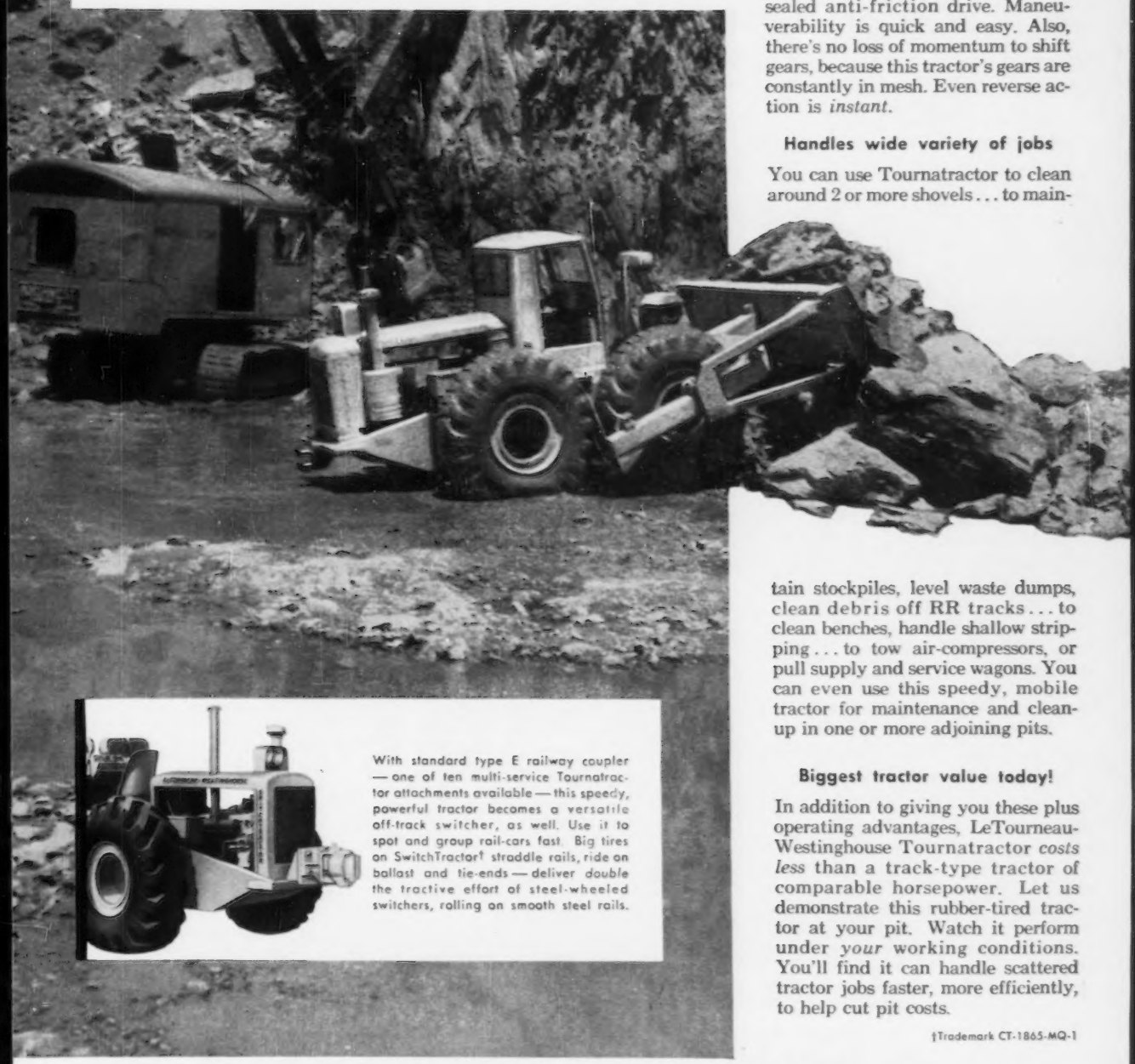
THE MINE AND SMELTER SUPPLY CO.

DENVER 16, 3800 RACE — NEW YORK 17, 122 E. 42ND ST. — SALT LAKE CITY 1, 121 W. 2ND S. — EL PASO, P. O. BOX 1162

SALES AGENTS AND LICENSED MANUFACTURERS THROUGHOUT THE WORLD

MARCY®

Why use separate machines and operators on scattered tractor jobs?



Handle your widely-separated pit maintenance and clean-up jobs swiftly and economically with one man and a LeTourneau-Westinghouse Tournatractor®. Rubber-tired tractor speeds to the job under its own power . . . over RR tracks, paved roads, down shot banks, or cross country. There are no delays for load-and-haul to new locations.

L-W tractor gives you better speed at the work area, too. Acceleration is fast, with 210 hp operating through sealed anti-friction drive. Maneuverability is quick and easy. Also, there's no loss of momentum to shift gears, because this tractor's gears are constantly in mesh. Even reverse action is *instant*.

Handles wide variety of jobs

You can use Tournatractor to clean around 2 or more shovels . . . to maintain stockpiles, level waste dumps, clean debris off RR tracks . . . to clean benches, handle shallow stripping . . . to tow air-compressors, or pull supply and service wagons. You can even use this speedy, mobile tractor for maintenance and clean-up in one or more adjoining pits.

With standard type E railway coupler — one of ten multi-service Tournatractor attachments available — this speedy, powerful tractor becomes a versatile off-track switcher, as well. Use it to spot and group rail-cars fast. Big tires on SwitchTractor† straddle rails, ride on ballast and tie-ends — deliver *double* the tractive effort of steel-wheeled switchers, rolling on smooth steel rails.

Biggest tractor value today!

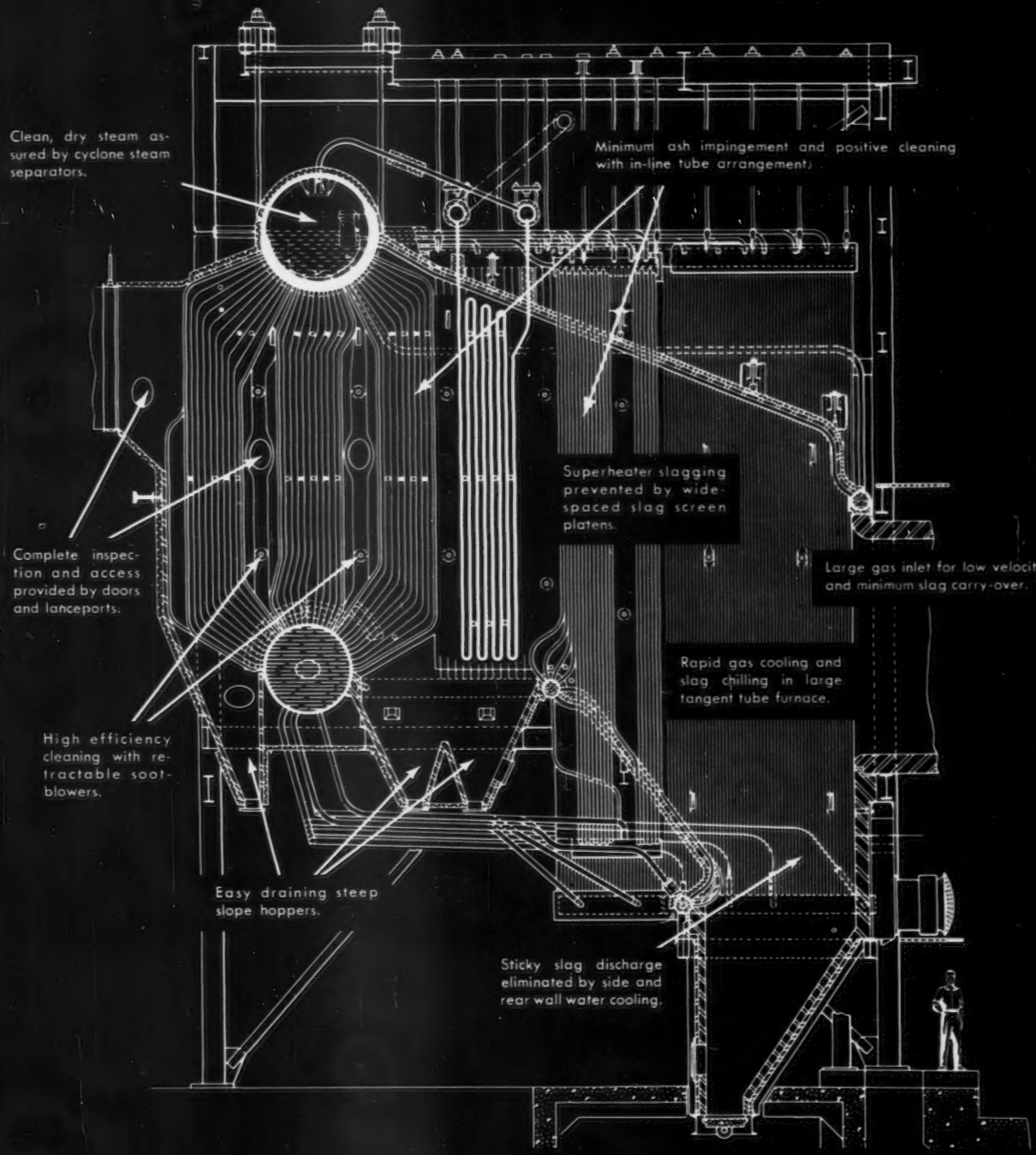
In addition to giving you these plus operating advantages, LeTourneau-Westinghouse Tournatractor *costs less* than a track-type tractor of comparable horsepower. Let us demonstrate this rubber-tired tractor at your pit. Watch it perform under *your* working conditions. You'll find it can handle scattered tractor jobs faster, more efficiently, to help cut pit costs.

†Trademark CT-1865-MQ-1

LeTOURNEAU-WESTINGHOUSE COMPANY, PEORIA, ILLINOIS

A Subsidiary of Westinghouse Air Brake Company

Where quality is a habit


Clean, dry steam assured by cyclone steam separators.
Minimum ash impingement and positive cleaning with in-line tube arrangement.
Superheater slagging prevented by wide-spaced slag screen platens.
Complete inspection and access provided by doors and lanceports.
Large gas inlet for low velocity and minimum slag carry-over.
Rapid gas cooling and slag chilling in large tangent tube furnace.
High efficiency cleaning with retractable soot-blowers.
Easy draining steep slope hoppers.
Sticky slag discharge eliminated by side and rear wall water cooling.

These important design features assure trouble-free, continuous operation of this B&W Waste Heat Boiler

Empresa Nacional de Fundiciones, Paipote, Chile, uses this B&W Waste Heat Recovery Boiler to produce 42,500 lb steam per hour at 400 psig and 700 F at the superheater outlet.

HOW TO SOLVE WASTE HEAT BOILER PROBLEMS

B&W heat recovery system ends production bottleneck

A major problem in waste heat boiler operation is the fouling of steam generating surfaces by slag and ash from the process. Frequent outages and excessive labor for boiler cleaning add substantially to the cost of any plant operation. Production delays can result in further serious losses.

For example, the Empresa Nacional de Fundiciones copper smelter at Paipote, Chile was experiencing difficulty in handling high temperature corrosive gases with considerable slag and metallics carryover. Slagging of boiler surfaces was severely limiting plant production. Unscheduled smelter shutdowns resulted in excessive refractory maintenance, high operating costs, and production losses.

B&W's engineers were asked to design a boiler to provide trouble-free operation for these difficult ash and slag conditions. An important requirement was that the new system be installed without interrupting plant operation. Utilizing the extensive experience gained from similar installations, B&W recommended a special, single pass, low draft loss boiler for the specific plant conditions at Paipote. B&W's recommendations for a completely engineered system were accepted and a waste heat boiler, flues, dust handling equipment, and auxiliaries were furnished.

The successful elimination of the waste heat handling problems, previously limiting production and causing high maintenance costs, has now been proved by several months of operation. In fact, plant production is now above design capacity.

B&W's extensive research and engineering facilities, plus its broad field experience in design and operating requirements in the metallurgical process industry, are available to solve your problems. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

BABCOCK & WILCOX

BOILER DIVISION

ME-100

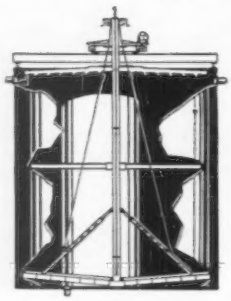
HARDINGE COMPANY, INCORPORATED

YORK, PENNSYLVANIA

NEW YORK • TORONTO • CHICAGO • HIBBING • HOUSTON • SALT LAKE CITY • SAN FRANCISCO • BIRMINGHAM • JACKSONVILLE BEACH

AGITATING

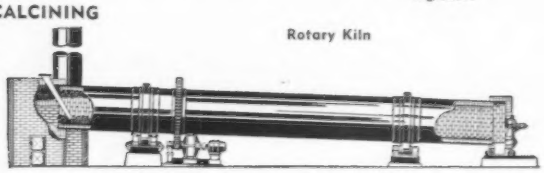
Hardinge combined mechanical and air Agitators are used to mix, agitate or store clay slurries, as well as metallurgical and chemical pulps. Compressed air is delivered to the bottom of the torque tube (which acts as an air lift) and to various points near the ends of the rotating scrapers. Pulp is fed and withdrawn continuously or intermittently, as desired. The drive mechanism is supported on ball bearings in an oil-filled, totally enclosed housing. The scraper raising winch is in easy reach and away from possible splash of pulp. Bulletin 31-E-1.



Agitator

CALCINING

Rotary Kiln



For small and medium capacity requirements, Hardinge offers the Ruggles-Coles Rotary Kiln for continuous calcining, roasting or oxidizing operations. It may be fired by oil, gas or pulverized coal. Bulletin 16-D-1.

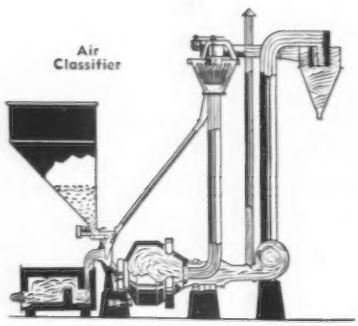
Hardinge also makes a line of vertical shaft kilns, both direct-fired and mixed-feed types. The Keystone Lime Kiln is ideal for smaller operations using coal, coke, oil or gas for fuel. Bulletin 23-A-1.

CLASSIFYING • SEPARATING

Dry Classifiers

The Hardinge "Gyrotor" Air Classifier, operating in conjunction with the Hardinge Mill, is a compact, self-contained unit of unusual efficiency. The material is conveyed without auxiliary apparatus to any convenient location in the building. The Hardinge "Gyrotor" Air Classifier provides extremely close product control. Bulletin 17-C-1.

Air Classifier



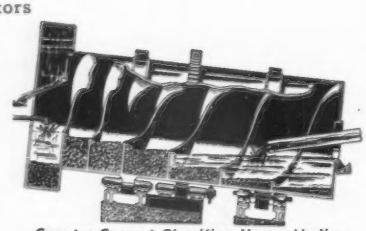
Wet Classifiers

The Hardinge Counter-Current Classifier is used for making size separations of ores and sands. It consists of a slowly rotating drum, on the inner surface of which is attached a screw flight. Will operate in closed circuit with a grinding mill without the use of conveyors or pumps. The Hardinge Hydro-Classifier is a large-volume classifier for fine separating problems. Bulletin 39-C-1.

Hydro-Classifier

Heavy Media Separators

The Counter-Current unit is also used as a Heavy-Media Separator. The "Sink" is separated from the "Float" by the screw flights as shown. The unit has only one moving part, is very efficient and will start up fully loaded. Bulletin 39-B-1.



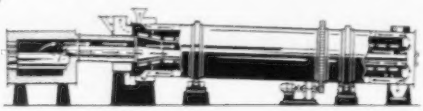
Counter-Current Classifier, Heavy-Media Separator

COOLING

Ruggles-Coles Rotary Coolers are employed for cooling hot materials after high temperature drying or calcination. There are three types: the air type, utilizing an induced cool air stream; the water type, either partially submerged (illustrated) or with exterior sprays cooling the shell; and the water tube type. Bulletin 16-D-1.

Rotary Cooler

DRYING



Class XB Double-Shell Rotary Dryer

There are six distinct types of Ruggles-Coles double- and single-shell Rotary Dryers, designed for direct, indirect and steam heat. Bulletin 16-D-1.

Class XA — This double-shell, semi-direct-heat dryer has the highest thermal efficiency and lowest fuel consumption of any rotary dryer manufactured. Particularly adapted for coal drying.

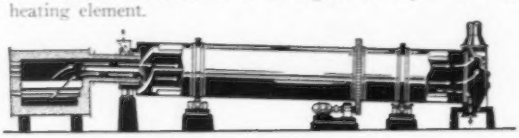
Class XB — A double-shell, indirect-heat dryer designed to handle such materials as kaolin, chalk, whiting, china clay, pigments, fuller's earth.

Class XC — A rotary steam tube dryer for drying materials that are injured by high temperature such as brewers' grain, cotton seed, starch feed, tobacco stems and corn germs.

Class XF — Single-Shell, counter-flow dryer for high drying temperatures.

Class XH — A single-shell, parallel-flow dryer, especially designed to handle flotation concentrates without sticking and without excessive dust loss.

Class XW — Used almost exclusively for drying inorganic salts and similar materials. It is a single-shell dryer with steam coil heating element.



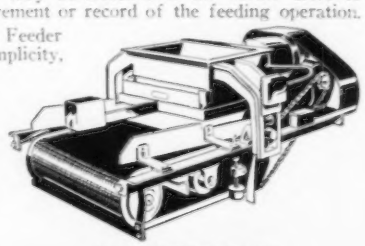
Class XH Single-Shell Rotary Dryer

FEEDING

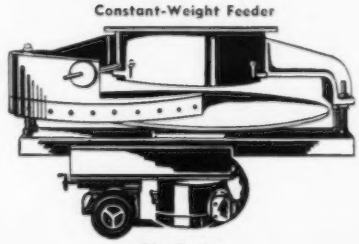
The Hardinge Constant-Weight Feeder measures by weight, not volume, thus compensating for variations due to changes in specific gravity, bulking or size of material. The feeder is quite accurate, and it affords automatic feed control for crushers, pulverizers, mixers, dryers, kilns, furnaces and conveyors. The feeder is bin-supported, requires little headroom. An indicating, totalizing or recording tachometer may be attached to the feeder drive to provide a weight measurement or record of the feeding operation.

The Hardinge Disc Feeder is outstanding in its simplicity, sturdiness and ease in adjustment. Particularly suitable for handling bulky, sticky, hot materials. Economical in cost and requires a minimum of headroom.

Other Hardinge regulating feeders are: the Volumetric Belt Feeder which provides uniform volume feeding control; and the Volumetric Non-Flooding Drum Feeders which employ the rotary pocket principle. Bulletin 33-E-1 describes the entire feeder line.



Constant-Weight Feeder



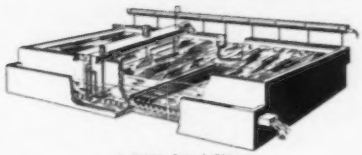
Disc Feeder

HARDINGE COMPANY, INCORPORATED

YORK, PENNSYLVANIA

NEW YORK • TORONTO • CHICAGO • HIBBING • HOUSTON • SALT LAKE CITY • SAN FRANCISCO • BIRMINGHAM • JACKSONVILLE BEACH

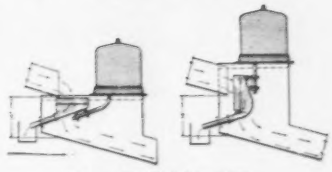
FILTERING



A.B.W. Sand Filter

The Hardinge Automatic Backwash Rapid Sand Filter cleans its own filter bed, a section at a time, automatically, without shut-down or change-over. Primarily adapted to the filtering of water containing small amounts of suspended particles that cannot be properly collected in settling basins or clarifiers. Used for filtering municipal water supplies, industrial water supplies, and certain presettled industrial waste waters to permit their re-use. Bulletin 46-A-1.

SAMPLING



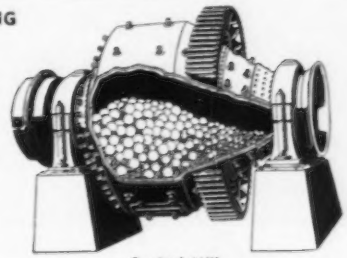
Automatic Wet Samplers

The Hardinge Automatic Sampler is simple in design, rugged in construction and offers a wide selection of sampling intervals and cutter openings. Accurate, continuous and trouble-free operation. Available for wet or dry processes. Wet models illustrated; type "A" cutter (left), type "B" (right). Bulletin 47-1.

GRINDING—PULVERIZING

Conical Mills

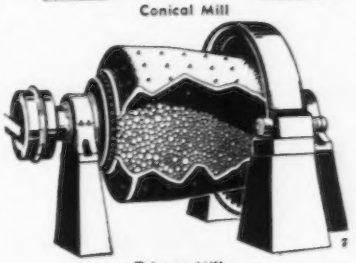
The shape of the Hardinge Conical Mill causes a rapid circulating and classifying action within the drum, which increases the capacity for power expended over other types. The grinding range is large, due to the segregation of the sizes within the mill. Sizes range from 2 feet to 10 feet with capacities from a few pounds per hour to 100 tons per hour. Bulletin 17-C-1 gives dry grinding applications; Bulletin AH-389-1 wet grinding.



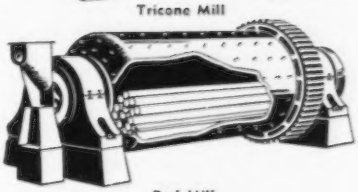
Conical Mill

Tricone Mills

Built on the same principle as the Conical Mill, the Tricone Mill offers greater grinding volume for a given amount of floor space than any other tumbling mill built. Extremely efficient. Ideal for large tonnages. Sizes up to 12 ft. diameter. Bulletin AH-414-1.



Tricone Mill



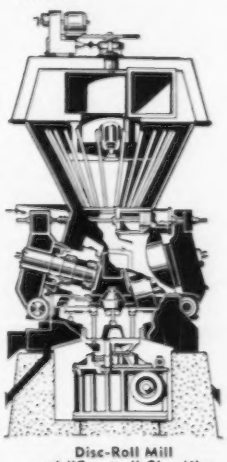
Rod Mill

Rod Mills

Steel rods are employed as grinding media. Ideal for producing minimum oversize in open circuit grinding. Convex or conical heads reduce friction, prevent congestion of charge at the ends, and align the rods. Available with either end, or center, peripheral discharge, as well as trunnion overflow. Bulletin 25-C-1.

Disc Roll Mills

An adaptation of the German "Loesche Mill." A roller mill with rotating grinding table and pneumatically-loaded rolls for complete flexibility of operation. The "Gyrotor" Classifier, combined with the Disc Roll Mill, provides a highly-efficient dry-grinding device, ideal for relatively soft minerals. Bulletin 52-1.

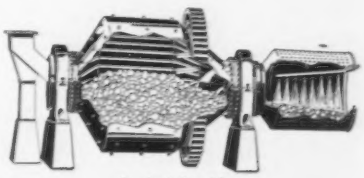


Disc-Roll Mill and "Gyrotor" Classifier

"Electric Ear"®

A revolutionary principle of control that automatically regulates the feed rate of a mill to keep it operating at maximum efficiency by "listening" to the sound. Mill capacity is increased 10% to 20%. Bulletin 42-A-1.

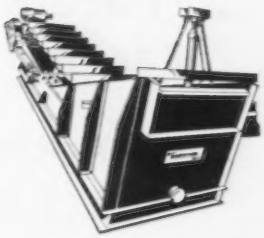
SCRUBBING



Conical Scrubber

The Hardinge Conical Scrubber cleans by mass contact and natural displacement. This action removes dirt and silt without wear on the scrubber. The classifying action of the cone holds back the large clay balls until properly disintegrated. Foreign materials, such as sticks, vegetation or large pieces of metal, can do no harm. Power required is low, and water requirements are considerably less than that of other methods. Repair costs are negligible. Bulletin 37-B-1.

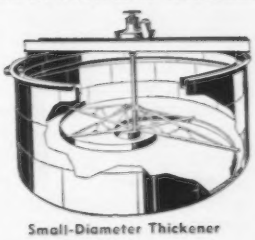
"Overdrain" Classifier



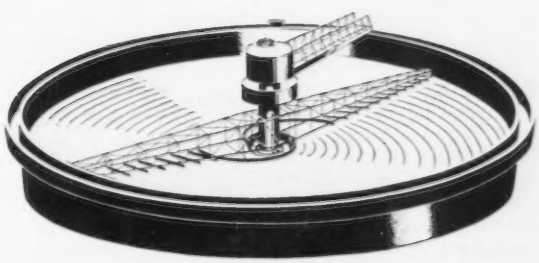
The Hardinge Overdrain Classifier is used for desliming and dewatering fines. Its "overdrain" action, based upon an entirely new principle, makes it an extremely efficient washing device. Requires only half the power of standard screw or rake type classifiers. Bulletin 39-C-1.

THICKENING

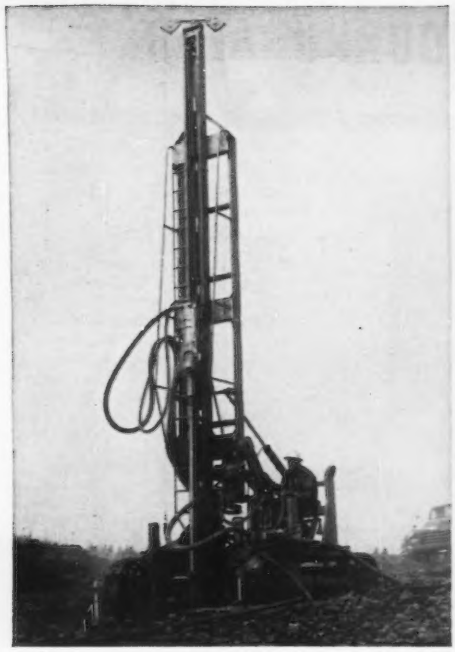
The distinctive features of the Hardinge Thickener are the spiral scrapers, which clean the bottom of the tank with each revolution, and the "Auto-Raise" driving mechanism which automatically lifts the scrapers away from an overload or obstruction in the tank bottom, thus eliminating costly breakdowns and delays. Can be operated very slowly, causing a minimum of disturbance. Produces a clearer overflow and a thicker discharge than other types. Small thickener mechanisms are supported on beams, spanning the tank. The large units carry the mechanism on a central concrete pier. Bulletin 31-E-1.



Small-Diameter Thickener



Large-Diameter Thickener



Gardner-Denver DH-143

Gardner-Denver Rotary 600

Pace Setters for Open Pit Production... Gardner-Denver Quality Drilling Equipment

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SUPER 5½" DH143 CRAWLER DRILLS—self-propelled heavy-duty drill. Packs plenty of deep hole punch in all formations.

DELUXE "AIR TRAC"® CRAWLER DRILLS—all controls for drilling, drill positioning and crawler drive are centralized for ease of operation. Available with 4" or 4½" drills. Also "Air Trac" without remote controls.

NEW GARDNER-DENVER "MOLE-DRIL"*—for use with rotary rig. An in-the-hole drill in two models for drilling 4¾" and 6½" hole in hardest rock.

WAGON DRILLS—light- and heavy-duty for every need.

AUGER DRILLS—both wagon drills and "Air Tracs" can be equipped with rotary motor for auger drilling.

QUARRY DRILLING AND BROACHING DRILLS.

DEEP HOLE DRILLS, DRIFTERS AND SINKERS—a complete line.

AIR FEED LEG DRILLS—and air feed legs for sinker mounting.

DRILL FEEDS AND CONTROLS—to fit every drilling job.

For Quality Drill Steel . . .

SECTIONAL DRILL RODS—highest quality—shot-peened and carburized to stand down-the-hole gaff longer.

RING SEAL SHANKS—replaces old-type water swivel without adding additional length to drill.

COUPLINGS—extra long, extra hard threads—made for longer drilling life.

For Air Power . . .

GARDNER-DENVER ROTARY PORTABLE COMPRESSORS—five models that offer water-oil cooling for all-weather operation, "THRIFTMETER"® fuel control, easy-to-get-at parts for speeding maintenance, clutch that eliminates cold-weather dry compressor starting. Sizes from 125 cfm. to 900 cfm.

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For Building Your Own Jumbo . . .

JUMBO COMPONENTS—for tractor and truck mounting or building your own jumbo.

DRILL POSITIONERS—provide hydraulic swing and dump on end of booms for drill and feed positioning.

HYDRAULIC BOOMS—powered by creep-free hydraulic cylinders that operate at low pressures.

HYDRAULIC REMOTE CONTROLS—for remote-control operation of drills, feeds, drill positioners and booms from any centralized position.

Plus . . .

Bit Grinders • Centrifugal Pumps • Air Hoists • Drill Steel Shapers and Sharpeners • Sump Pumps • Air Maintenance Tools • Oil Forges • Air Line Oilers • Air Motors • Breakers • Tampers

*Trade-Mark

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RING SEAL SHANKS—replace old-type water swivels without adding additional length to drill.

COUPLINGS—extra long, extra hard threads for longer drilling life.

With air power . . .

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STATIONARY WATER-COOLED COMPRESSORS—single- and two-stage units in capacities to 1854 cfm.

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"AIRSLUSHERS"—three Gardner-Denver load-lugging slusher hoists available. Powered by high-torque, five-cylinder radial air motors. Motor and drive completely enclosed to keep out dirt and water.

In jumbo drilling setups . . .

HYDRAULIC DRILL JUMBOS—rail-mounted jumbo units with one, two or three booms, in your choice of drills and feeds.

JMT "MOBILJUMBO"®—a self-propelled, push-button drilling unit. Available with two or three booms . . . with drills and feeds to suit your ground.

JUMBO COMPONENTS—build your own jumbo with Gardner-Denver drills, feeds, hydraulic booms, remote controls and drill positioners. A combination for every drilling need.

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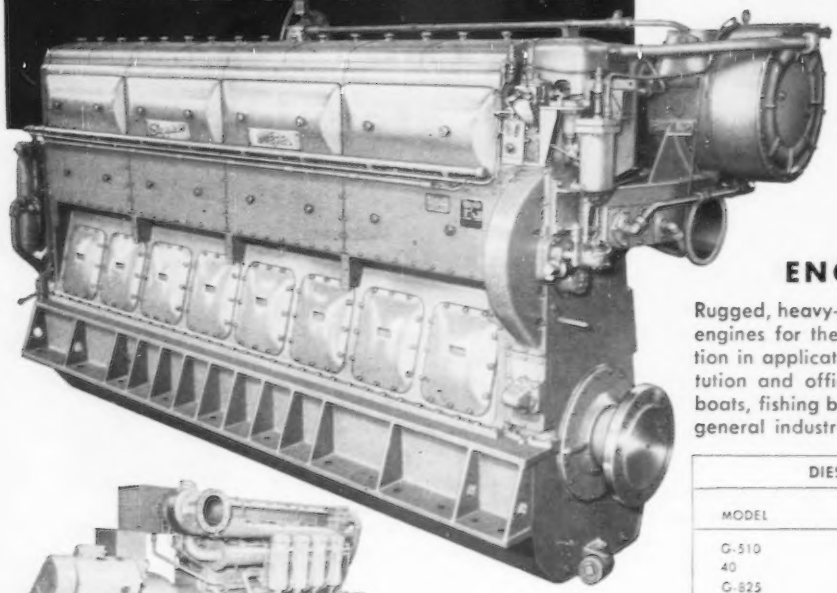

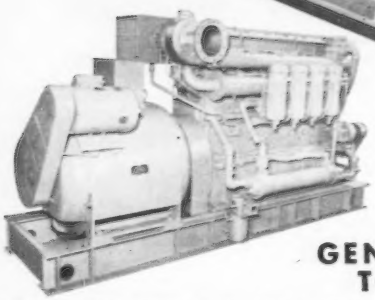

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G-825	G	300- 705	600- 900
60	D, DF	410-1325	400- 514
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D—Diesel; DF—Dual Fuel; G—Gas

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40-S-6	600	225	150	69⅛"	47¾"	171¾"
40-S-6	720	290	200	69⅛"	47¾"	171¾"
40-S-6	900	360	250	69⅛"	47¾"	171¾"
40-SX-6	900	430	300	71½"	47¾"	174⅜"
40-SX-6	900	505	350	71½"	47¾"	177⅞"
STANDARD A.C. GENERATOR SETS • NATURAL GAS ENGINES						
6G-510	720	225	150	65⅝"	45⅝"	149½"
6G-510	900	325	200	65⅝"	45⅝"	155"
6G-825	720	375	250	70"	61"	171¾"
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LINK-BELT Pre-Bilt Belt conveyors handle up to 1500 tons per hour

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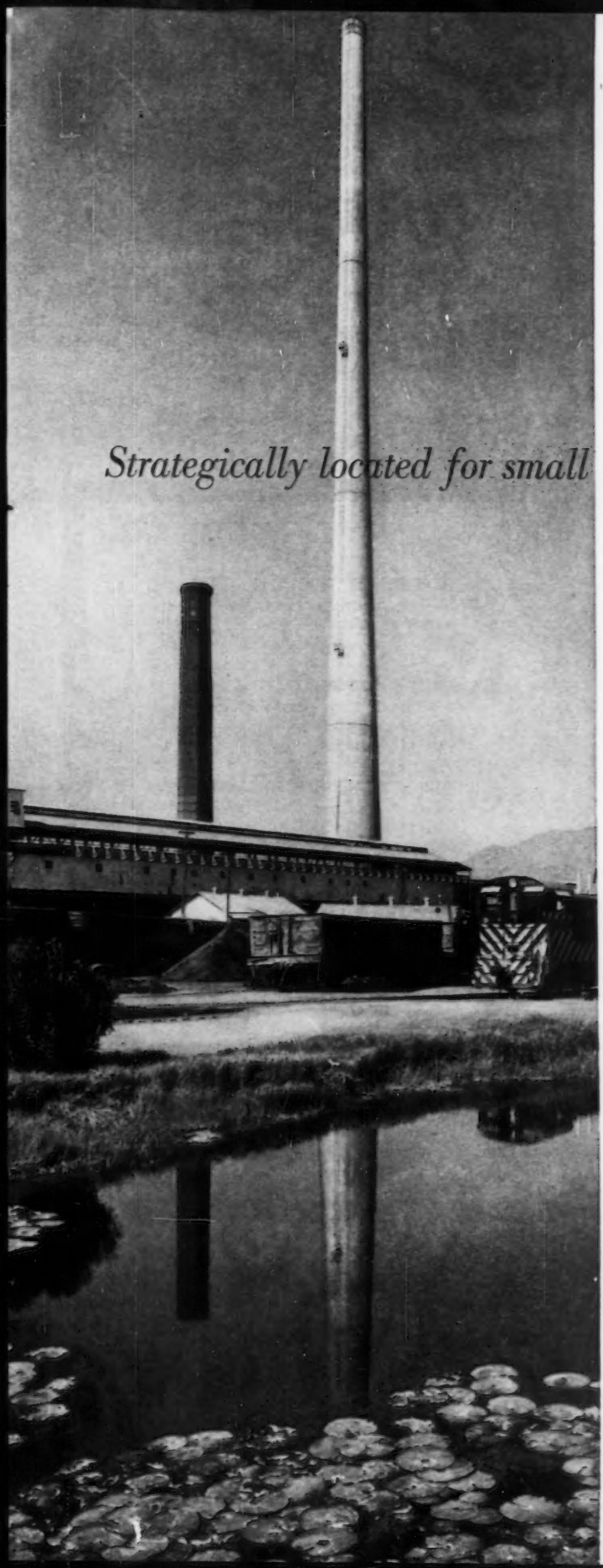

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ASARCO

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2 ENGINEERED SHELL—Bronze shell of a Hercules cap goes through fifteen separate operations while it is being expertly shaped.

3 TOUGH, HIGH DIELECTRIC INSULATION—Leg wires of Hercules caps are coated with plastic insulation for outstanding toughness, resistance to abrasion, superior dielectric qualities.

4 SECURELY ANCHORED—A cast sulfur plug in the upper part of shell anchors entire firing mechanism in place.

5 WATERTIGHT WATERPROOFING—A special Hercules waterproofing formulation minimizes the possibility of moisture or dampness penetration.

6 7 DOUBLE-PACKED WALLOP—Bridge wire extends into the priming charge and makes positive contact to give rapid ignition.

XRSB-1

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ENGINEER'S FIELD REPORT

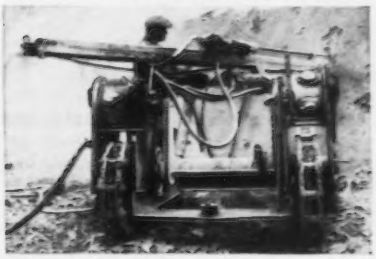
PRODUCT CHEVRON VISTAC OIL

FIRM NEVADA-MASSACHUSETTS COMPANY
Tungsten, Nevada

Special Oil holds wear to minimum for 15 yrs.

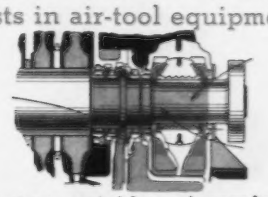
Nevada-Massachusetts Co., operators of one of the world's largest tungsten mines, has relied on Chevron Vistac Oil for 15 years, to keep their rock drills and other air tools operating at peak efficiency. "We use Vistac because it stays on the tools whether they're wet or dry. Doesn't create drag, either...we get full power with minimum tool wear," says general manager Eldridge Nash. Oil's tough, protective film resists high operating temperatures, helps this firm's rock drills (above) bore fifteen 2½-inch blasting holes averaging twelve feet in depth, in just eight hours. Nevada-Mass. does extensive underground mining at this site as well as surface operations.

Despite heavy abrasive dust from drilling in Hornfels and Scheelite, (above), Chevron Vistac Oil keeps rock drills working smoothly. Lubricant is used in 60 rock drills, 3 wagon drills, plus 25 tuggers (air motors) on hoist equipment, loaders, slusher hoists and sump pumps.



Special wagon drill, built at mine, uses Ingersoll Rand DA 35 rock drill to bore horizontal holes up to 18 ft. deep. EIMCO air motors lubricated with Chevron Vistac Oil power tracks for fast and easy maneuvering.

Why Chevron Vistac Oil cuts costs in air-tool equipment



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- Additives help form tenacious, oily, pressure-resistant film in wet or dry conditions—cuts wear and power loss.
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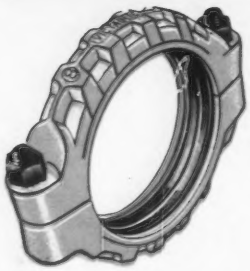

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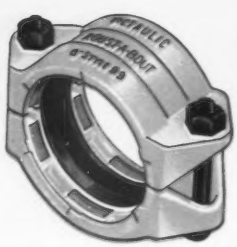

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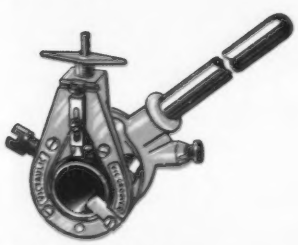

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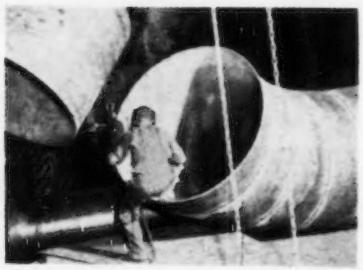

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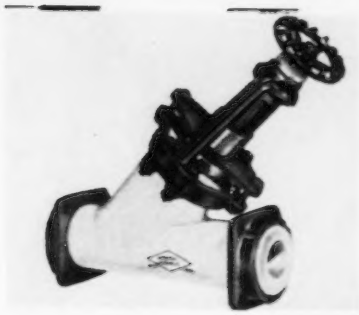

Where Are They

A COMPLETE CROSS-SECTION of the modern equipment, materials and services offered by manufacturers and service organizations is presented in this 1958 E&MJ Mining Guidebook issue.

The Buying Guide Section is designed to help you in three major ways:

1. If you need equipment, materials and services not previously used . . .

2. If you are interested in additional sources of equipment, materials and services . . .

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Check the Buying Guide first. Find the product in the alphabetical list. Under it will appear the names of the key manufacturers, with those advertising in this issue indicated by black-faced type.

Consult the manufacturers' advertisements in this issue for information on specific products, materials and services. To locate the local source of supply nearest you, check the list of advertisers' district sales offices provided at the end of this issue.

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for COPPER furnaces

CHROMEX B

The desirable properties which account for the excellent service secured from this extra hard fired chrome-magnesite refractory are: —high density and impermeability—relatively low thermal expansion and good resistance to thermal shock—unusual stability and strength at high temperatures. Among the important applications for this brand in copper furnaces are its use in converter linings, complete walls of refining furnaces and vulnerable positions in roofs. It is used with excellent results in linings of electric copper melting furnaces.

THERMAG

This hard burned magnesite-chrome refractory possesses the chemical and physical properties which make it particularly suited for roofs of electric furnaces used for melting copper.

H-W MAGNESITE

For the most strongly basic linings, this refractory, consisting predominantly of periclase (stabilized crystalline magnesia), fulfills the most severe requirements. It is fired at an extremely high temperature and is dense, strong and volume-stable at temperatures above the highest employed in copper furnaces. The unusually high magnesia content of H-W MAGNESITE, together with its outstanding physical properties account for the wide preference this refractory continues to gain for use in various metallurgical furnaces.

METALKASE AND METALKASE XXP

Among basic refractories, Harbison-Walker METALKASE brick possess the property of maximum resistance to severe spalling conditions. METALKASE brick are furnished in various sizes and shapes. They are made in both chemically-bonded and hard fired basic refractories of various compositions which are widely used with particular benefit in suspended roofs and walls in the several types of metallurgical furnaces.

METALKASE XXP are chemically-bonded basic brick, formed under high pressure, with two internal plates. They are available in various compositions and are furnished in standard sizes, and suspended arch and other shapes.

STAR AND VEGA

These two superior silica brick now are made at seven widely separated Harbison-Walker plants. Shipments from these advantageous locations provide important savings in transportation time and cost.

STAR brand is regarded as standard for refining furnace bottoms and roofs at many plants. It is used in reverberatory Matte smelting furnace roofs and in a number of electric smelting furnaces of different designs.

VEGA is the original super-duty high temperature silica brick from which greatest benefit is derived in vulnerable positions where extremely severe operating conditions prevail.

for ALUMINUM furnaces

Refractories which are best suited for use in aluminum melting and holding furnaces possess properties which meet various specific requirements. In some furnaces the refractories in the bottoms are subjected to severe impact and abrasion. In the production of various alloys to meet certain rigid specifications, the refractories used must be such that any contamination, such as silicon pick-up, is avoided. High resistance to wetting and penetration by molten metal is paramount.

KORUNDAL

The unusual combination of desirable physical properties of this 90% alumina refractory makes it particularly adapted for use in bottoms and lower side walls. KORUNDAL is very strong and resistant to mechanical abuse, wetting by molten aluminum and to thermal spalling. This brand, made in modifications such as KORUNDAL DOT and KORUNDAL F, serves various specific needs to greatest advantage.

H-W SILICON CARBIDE

Some of the most important physical properties of this refractory are measurably enhanced by developments in manufacturing procedures. Many sizes and shapes are formed by impact under great pressure which accounts for increased density and strength. High temperature firing in a closely-controlled atmosphere contributes to the formation of an exceedingly impervious surface and lower permeability. It is unusually resistant to oxidation and wetting by molten metals and can be used in various furnace positions.

ALAMO

Along with other Harbison-Walker super-duty fireclay brick brands, ALAMO is favored for upper walls and roofs. Harbison-Walker products for aluminum furnaces comprise several other brands of high-alumina and high duty fireclay brick possessing the particular properties needed for best performance in this service.

BONDING MORTARS

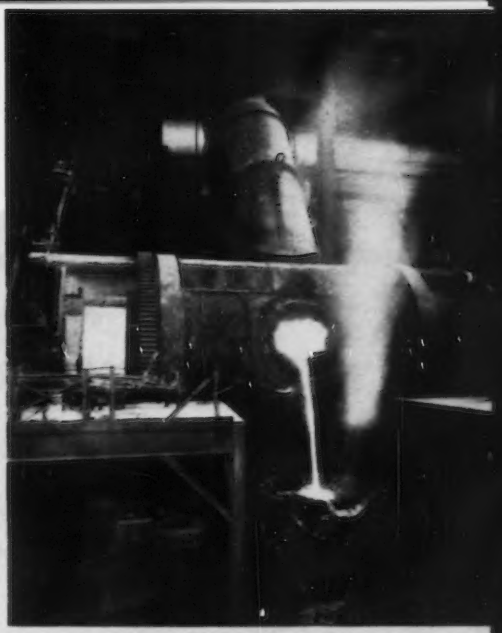
HARWACO BOND (diaspore base), THERMOLITH (chrome base) and KORUNDAL BONDING MORTAR (stabilized alumina base), cold-setting high temperature bonding mortars have unusually high strength for the temperature range of their use. While these may be used interchangeably for laying the various types of brick, each provides special benefits for particular applications.

H-W MONOLITHIC MATERIALS

KORUNDAL RAMMING MIXTURE . . . H-W CHROME CASTABLE . . . H-W EXTRA STRENGTH CASTABLE and H-W PLASTIC FIRE BRICK among the full complement of Harbison-Walker monolithic refractories are especially adapted for aluminum furnace requirements. They are favored in this industry because of the pronounced properties of volume stability, low thermal expansion and high resistance to both penetration and abrasion.

REFRACTORIES

for dependable performance in every metallurgical operation



for OTHER NON-FERROUS furnaces

The service conditions in furnaces employed in the numerous non-ferrous metallurgical processes vary widely, and the refractories must meet highly specialized requirements. The selection of the proper refractory frequently governs the degree of success of the processes employed in the reduction, refining and melting of these metals. Harbison-Walker products comprise all the different types and classes of refractories needed for all the metallurgical processes, such as for the reduction and refining of nickel, lead, zinc, tin and other metals.

Extensive research and experience govern the selection of the particular Harbison-Walker refractories which serve best in metal chloride furnaces such as those used for making titanium and zirconium chlorides and for the production of metallic sodium and magnesium. Brands generally favored for these requirements are VARNON BF, H-W MULLITE and DURO.

SOME OTHER H-W BASIC REFRACTORIES

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MAGNEX
—a chemically-bonded magnesite-chrome brick—highly basic and of low spalling tendency.

H-W CHROME
—a hard burned chrome brick especially adapted for various specific uses.

FORSTERITE
—the only commercially produced magnesium-silicate brick—suited for certain particular applications.

H-W PERIKLASE
—an exceptionally high magnesia brick of unusual high-temperature stability.

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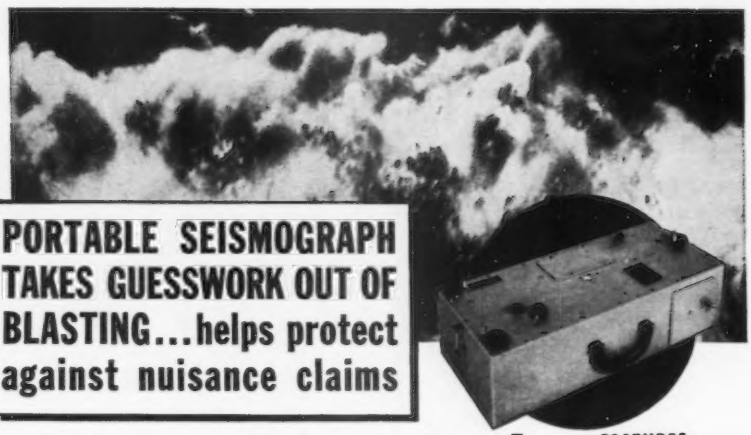

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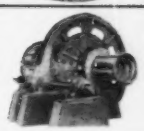
DENVER Steel-Head **BALL AND ROD MILLS**		3' x 2' to 10' x 20'	A Denver Steel-Head Ball or Rod Mill will suit your particular need. Five types of discharge trunnions. All-steel construction. Low initial cost due to quantity production. Quick delivery. Laboratory and pilot plant mills also available. You can depend on the strength of steel.	Bulletin No. B2-B13
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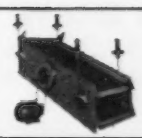
DENVER Dillon **SCREENS**		1' x 3' to 6' x 14'	Gives fast, clean separation without blinding. Gives even, smooth flow of material because of the patented "true-circle" eccentric action. Two bearing construction saves 50% HP.	Bulletin No. S3-B15
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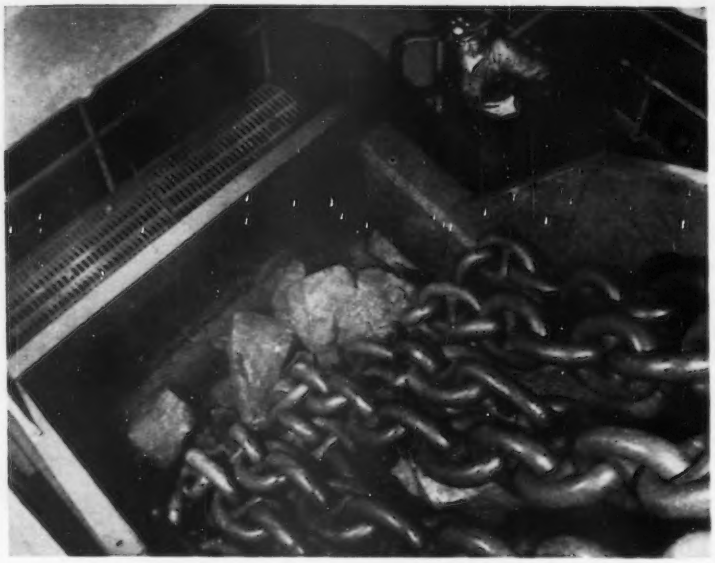

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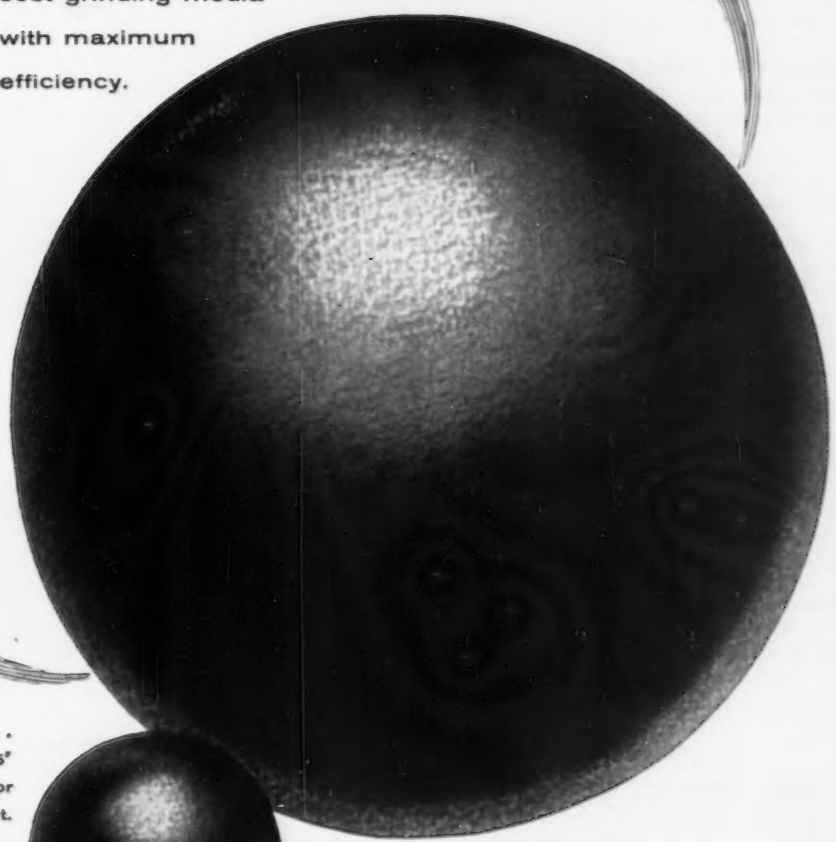

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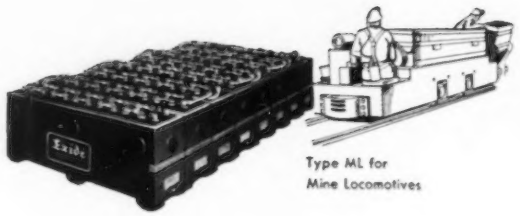

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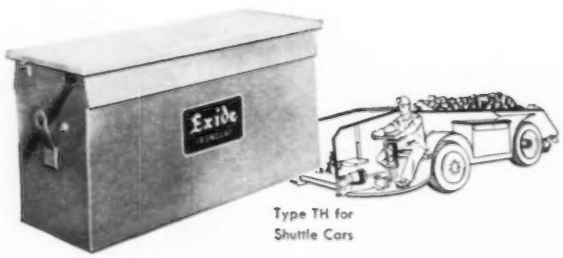
Longer plate life—active material is held firmly captive inside cylindrical power tubes, maintains electrical contact, can't shear off during cycling.

Pools of electrolyte next to plates—speed response to heavy load demands, insure maximum power from battery at all times, without delay.

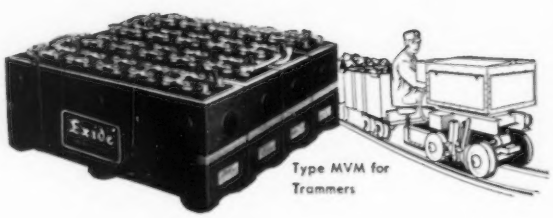
Silvium grids—exclusive patented Exide grid alloy resists corrosion, prolongs strength and thickness of grids, stretches battery life.

Vibration resistant—active material protected from shedding by cylindrical tubes, tiny openings let electrolyte in but keep active material from falling out; battery lasts longer in high vibration applications.

More active oxides—increase battery capacity, give Exide-Ironclad Batteries more power per pound; hence they have greater electrical efficiency.

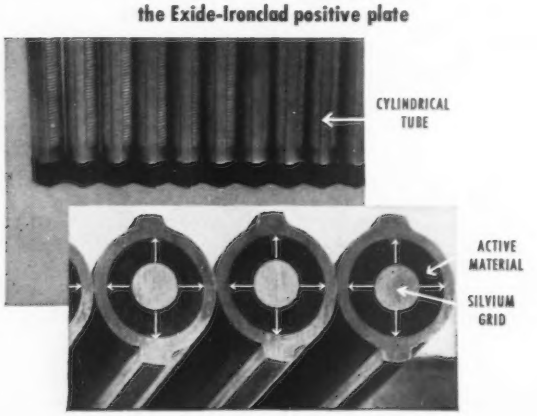


Type TH for
Shuttle Cars



Type MVM for
Trammers

Exclusive tubular construction of the Exide-Ironclad positive plate



For prices, specifications or free manual on maintaining motive power batteries, call or write the Exide sales office near you.

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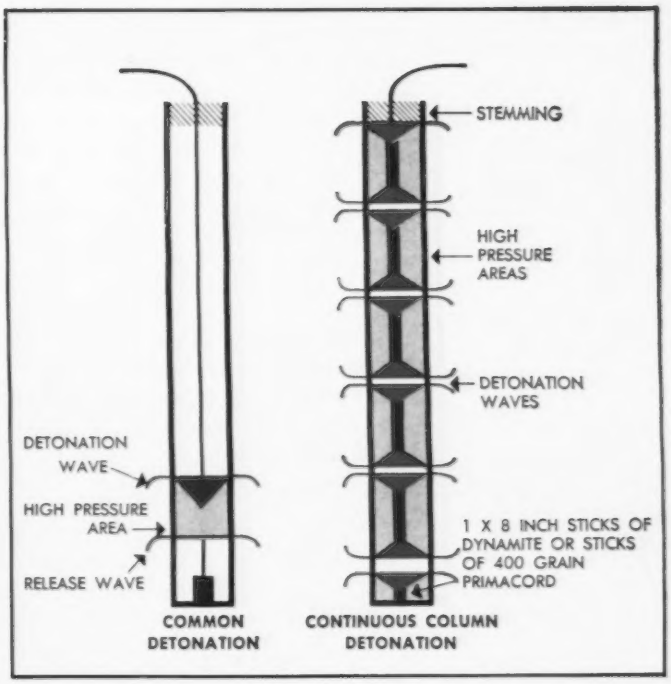
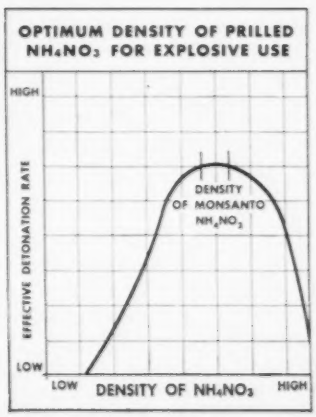
Explosives News from Monsanto Research

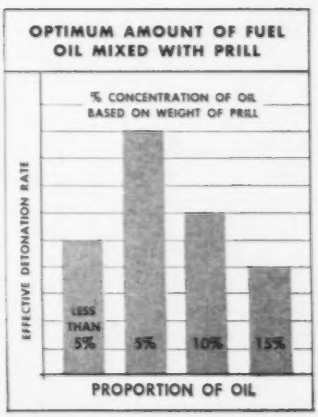
PRILLED AMMONIUM NITRATE IN CONTINUOUS COLUMN DETONATION GIVES BETTER BREAKAGE, SAVES DRILLING AND CRUSHING COSTS!

Continuous column detonation (right) gives better shatter because entire hole detonates approximately at speed of Primacord* (20,000 to 21,000 ft/sec.). Notice no release wave structure . . . entire hole works. Faster detonation cuts heat loss. Contained heat results in gas expansion—produces more work for less money. For the most favorable results, make sure hole is filled with NH_4NO_3 but don't risk destroying the best prill-pack by tamping. Pour oil in bag of Ammonium Nitrate. Let set for at least ½ hour before loading, or use mechanical mixer. Monsanto Ammonium Nitrate gives you optimum density of prilled NH_4NO_3 for explosive use *and* optimum prill size.



Ideal rock breakage, like this, reduces crushing costs. The Monsanto method of detonation, in conjunction with a new, top-quality prilled NH_4NO_3 that Monsanto research developed, will yield the equivalent of 60 % gelatin dynamite at ¼ the cost.





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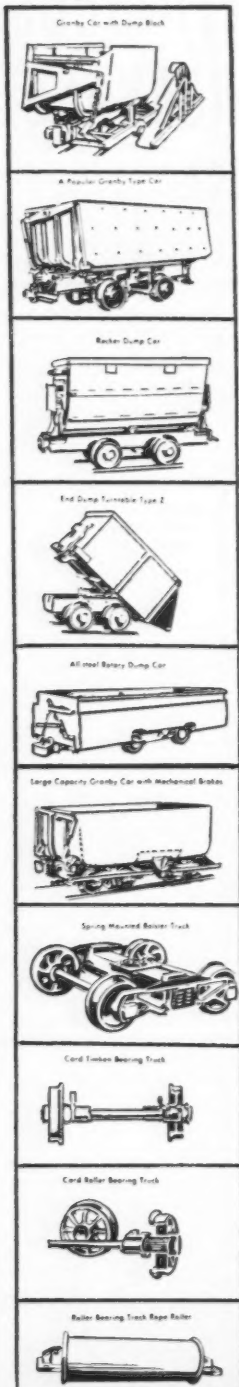

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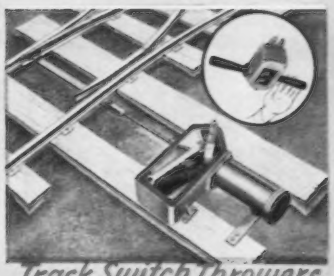

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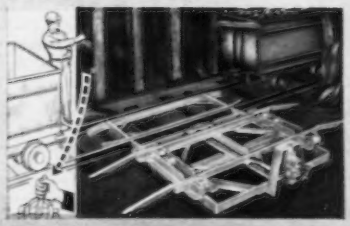
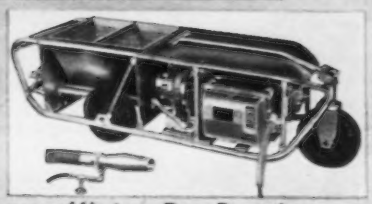


Canton Car Transfers

No alterations to track. Quickly installed and relocated—less rib to shoot than for jump switch—no hazards of cherry picker. Anti-friction bearings for easy hand operation. Manual or compressed air models available. (Air model illustrated.)



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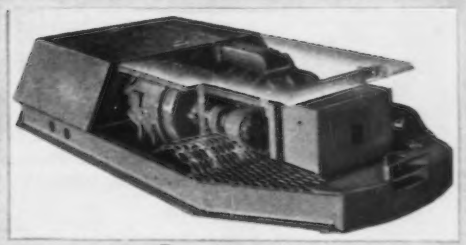
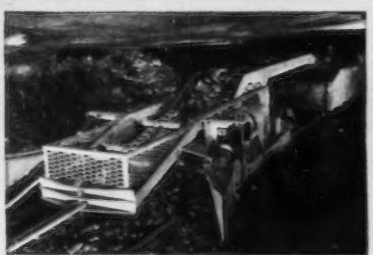
"Canton" Little Chief goes anywhere . . . rubber tire model 22½" high; skid model 18½" high for shuttle buggies, belts or mine cars; track-mounted for haulage roads. Delivers 34 to 60 lbs. dust per minute through 50 to 400 ft. 1¾" hose.



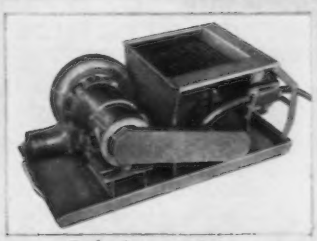
Dustmaster

The Track Mounted Hi-Pressure "Dustmaster" is the most powerful Duster ever built. Distributes dust to back areas 500 ft. from haulway.



Canton Track Cleaners

Hydraulic controls throughout clean entire track area mechanically in one pass—no costly hand labor; no dozers or loaders required. Now operating economically in coal, iron, copper, lead, potash, and salt mines.



Mighty Midget

Weighs only 280 lbs. Easily moved on shuttle car. Hand cart available. Ideal for small mines . . . inexpensive . . . capacity 7 tons per shift

Canton Cable Splicer

"Canton" Cable Splicers reduce down time in splicing cable. Machine men should carry a pocket ful. Just pound around cable and go on working. No special tools

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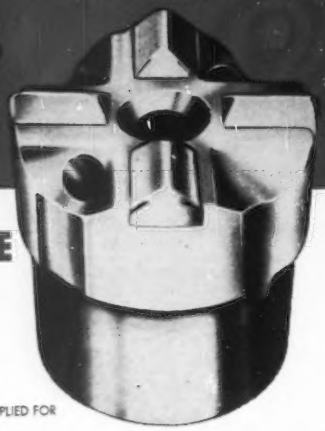

SPECIAL LONG LIFE INSERTS...FAST CUTTING ACTION

PATENTS APPLIED FOR

The exclusive shallow long life inserts need no resharpening because they do not develop a reverse taper dullness . . . a condition that stops drilling in the conventional multi-use bit. The exclusive design of LIDDICOAT permits fast drilling far beyond the point where conventional multi-use carbide bits must be withdrawn from service for resharpening. Fast drilling continues during the entire bit usage without need of resharpening. Lower first cost – low cost per foot of hole drilled.

Taper socket — No threads — Fast, firm attachment

The type TS Tee Cee Liddicoat (no resharpening) bit has a completely new short taper socket connection. Within the socket of the bit is a brass shim. The socket, which is completely forged, is tapered to correspond to the taper placed on the drill rod. The connection assures an absolute attachment to the rod, and yet permits easy removal.

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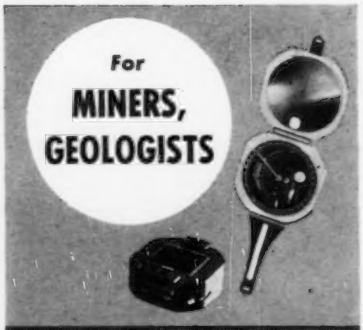

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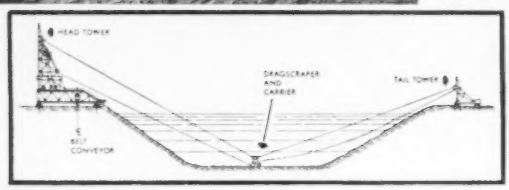
Tough Digging, Long Hauls... Routine Jobs for Sauerman DragScrapers

240-Ft. Bank... 350-Ft. Haul

This mobile Sauerman Tower Excavator digs 480 yds. per hr. on an average haul of 350 ft. from a high bank to a portable field hopper. The 12-yd. Crescent DragScraper operates between steel head and tail towers. The towers are mounted on two sets of railroad tracks and ride on four sets of trucks. DragScraper power is supplied by two hoists mounted on the head tower. One hoist operates the load and pullback cables, the other is used to tension the track cable. The hoists are controlled by one operator located in the cab on the tower. The load cable handles over 400,000 tons of material before replacement.



Drawing shows typical mobile tower excavator digging in wet pit.

75 Ft. Under Water... 800-Ft. Span

A 5-yd. rapid-shifting DragScraper supplies about 200 yds. per hr. to the plant hopper in background. Bridle tower in foreground is one of two supporting the bridle shifting cable which is controlled by the third drum of the Sauerman hoist. Lateral shifting of the DragScraper's line of operation is readily accomplished by power-shifting the trolley and tail block to a new position on the bridle cable. The DragScraper is digging 75 ft. under water and the operating span is 800 ft. from head frame to the bridle towers. Over a million tons have been excavated from this pit. The DragScraper often operates 24 hrs. a day to handle contract demands.

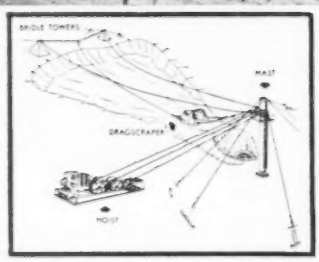


Diagram shows details of Sauerman rapid-shifting DragScraper.

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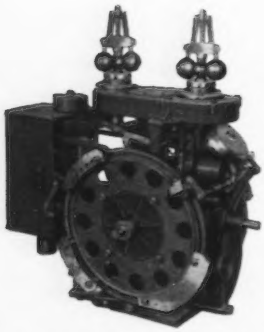
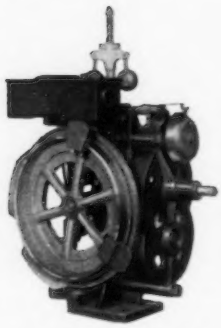
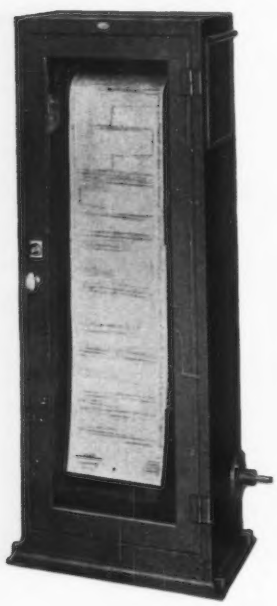


A MODEL C LILLY HOIST CONTROLLER with Duplex Governors. Model C Controllers are particularly suited to large and fast hoists. (See Catalog C-44)

A SIMPLEX HOIST CONTROLLER equipped with Depth Indicator and mounted on a Weight Unit with Regulating Cylinder for operating the brakes of small hoists. These units are best suited to small or relatively low speed hoists. (See Catalog S-46)



A MODEL D LILLY HOIST CONTROLLER assembled left hand. Model D Controllers are particularly suited to small or medium size hoists. (See Catalog D-44)



LOGAN HOIST RECORDER for recording all movements and delays of the hoist, and to provide a graphic picture of the manner in which it is operated. (See Catalog 447)

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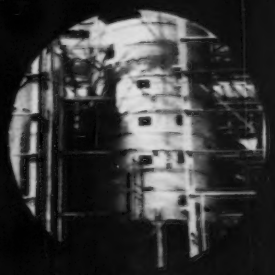

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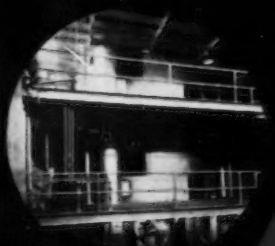

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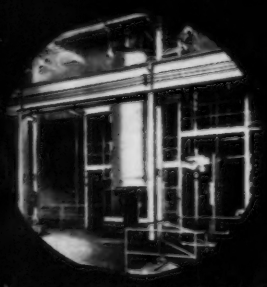

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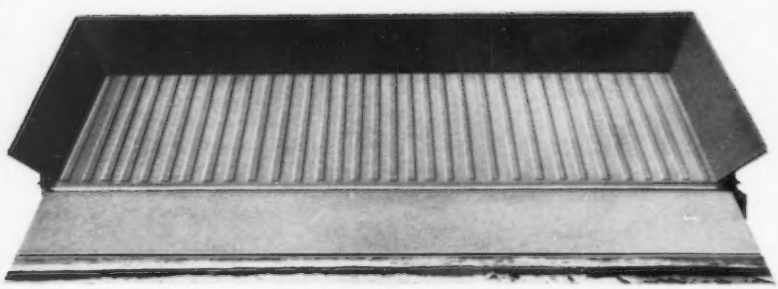
Through less maintenance, longer operating life and all 'round dependability, Magor Air Dump Cars save time and money on the job. An outstanding reason why Magor built automatic air dump cars are high on the preferred list of the nation's mining interests.

The 43 cubic yard, 100 ton capacity Air Dump Car shown here is but one of a large quantity recently furnished for a Taconite Mining operation in Minnesota. This car is equipped with a replaceable floor wearing surface of 1" thick low alloy, high tensile steel bars. These bars together with the 3/4" low alloy, high tensile steel floor afford the necessary strength to withstand the punishment of the hard rugged Taconite service.



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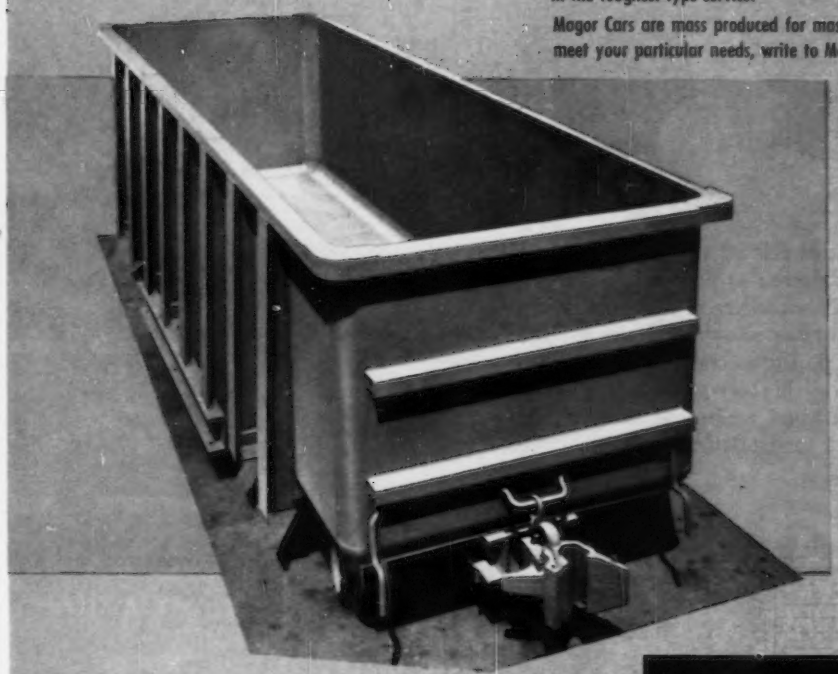
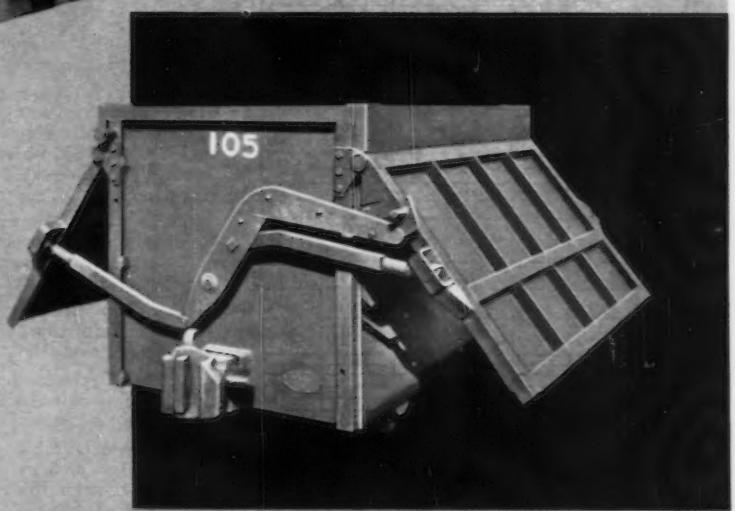
MAGOR

These two underground mining cars are typical of those manufactured by Magor to meet the needs of underground mining operators. Economy of operation is a big feature. The use of low alloy type steel together with construction methods designed to utilize the maximum advantages of these steels has produced cars capable of taking the toughest punishment in the toughest type service.

Magor Cars are mass produced for mass economies. For cars designed to meet your particular needs, write to Magor today.



One of a large quantity of underground type Ore Cars recently manufactured by Magor. This car has a capacity of 20 tons and is of all welded construction. Equipped with low alloy, high tensile steel floor, sides, and ends, this car is well able to withstand the severe service of underground mining. This car was furnished with double 4-wheel trucks and was designed for operating on track having a track gauge of 36".



A 5 ton capacity all steel underground Mine Car. The car, shown here in the "dumping" position, has an approximate length of 9'0", a width of approximately 4'10" and an approximate height above rail of 5'0". Equipped with four 14" diameter cast steel wheels, this car was designed for use on track having a track gauge of 36".

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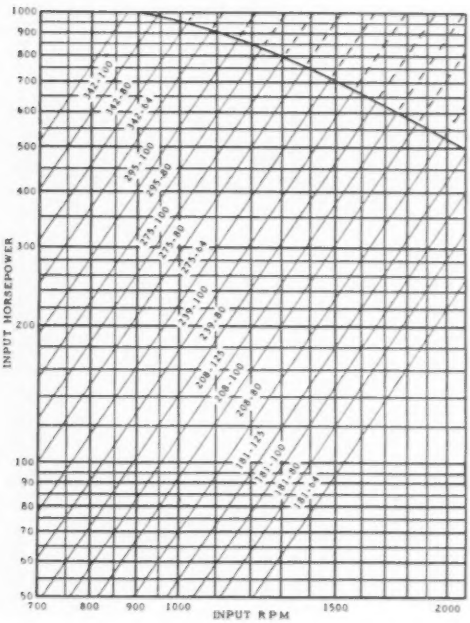

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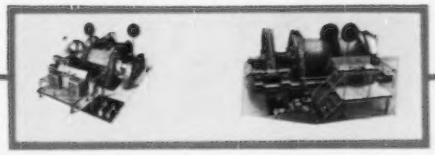
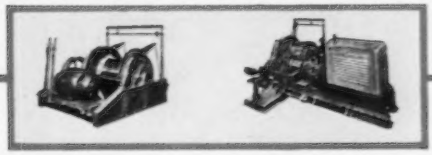


Custom built for special conditions at 15,000 to 30,000 lbs. rope pull. Radial acting dental clutches; brakes and clutches air or oil operated. Electrical control and safety equipment. For high production use.

LIGHT DUTY HOISTS



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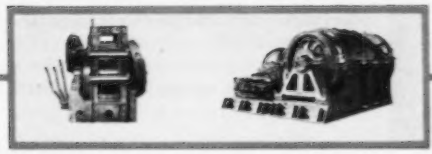
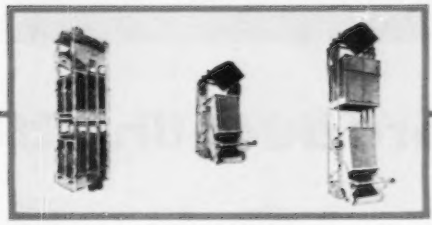


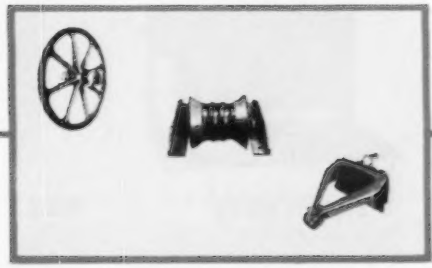
These 100 to 150 HP high capacity slushers are available in single or double drum models. Long used and continually reordered for large tonnage block caving operations. Wide choice in controls and features.

SKIPS and CAGES



Automatic bottom dumping skips are the coming thing. Vulcan vertical, self dumping skips or skip-cage combinations built to your requirements offer maximum strength and safety, high capacity-to-weight ratios. Vulcan cages are safe and easy running, available in various styles.

SHEAVES • ROLLERS • SCRAPERS



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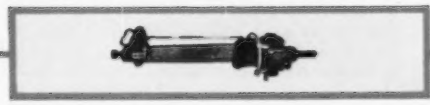

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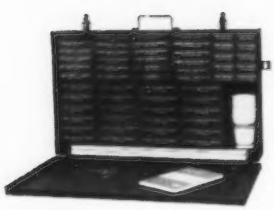

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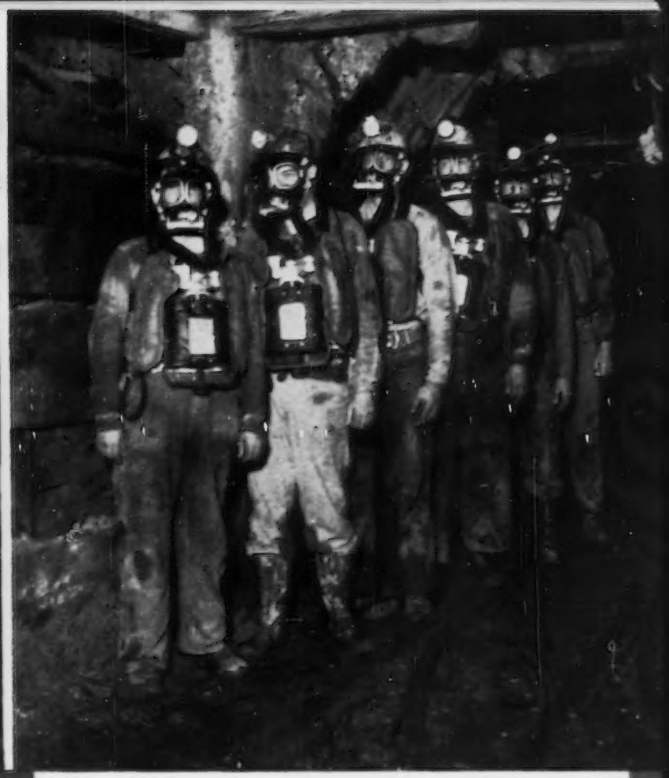

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AUSTIN-WESTERN... speeds production, reduces downtime

A-W Hydraulic Crane saves maintenance man-hours

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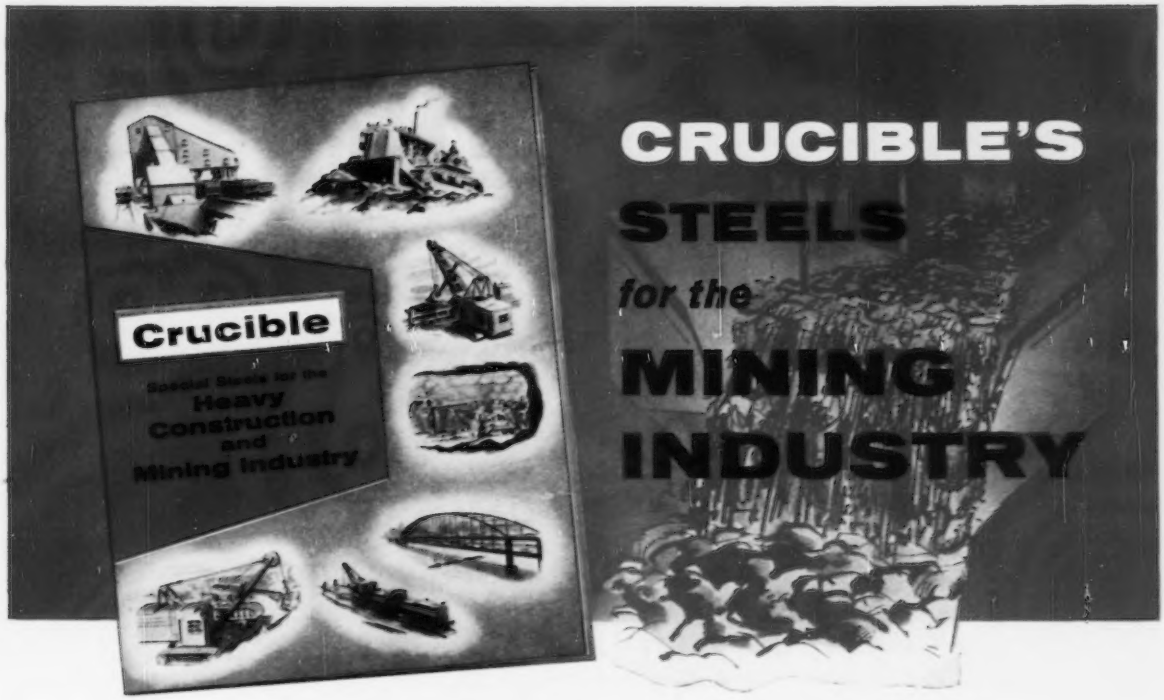

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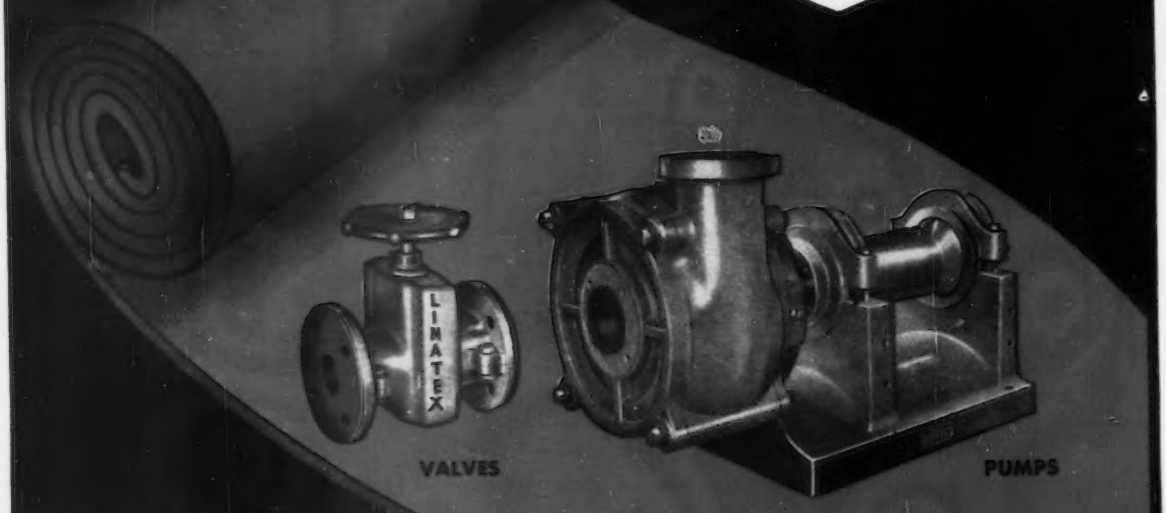

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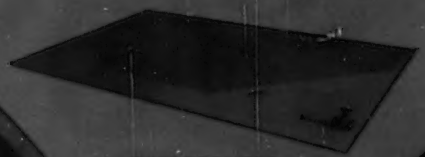

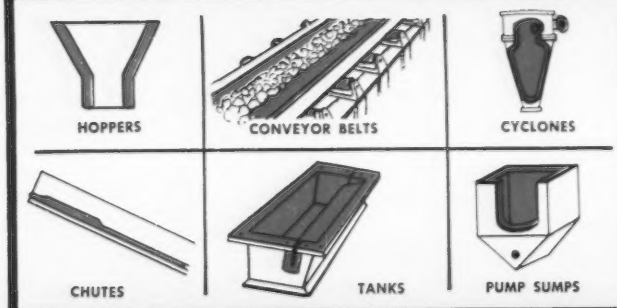

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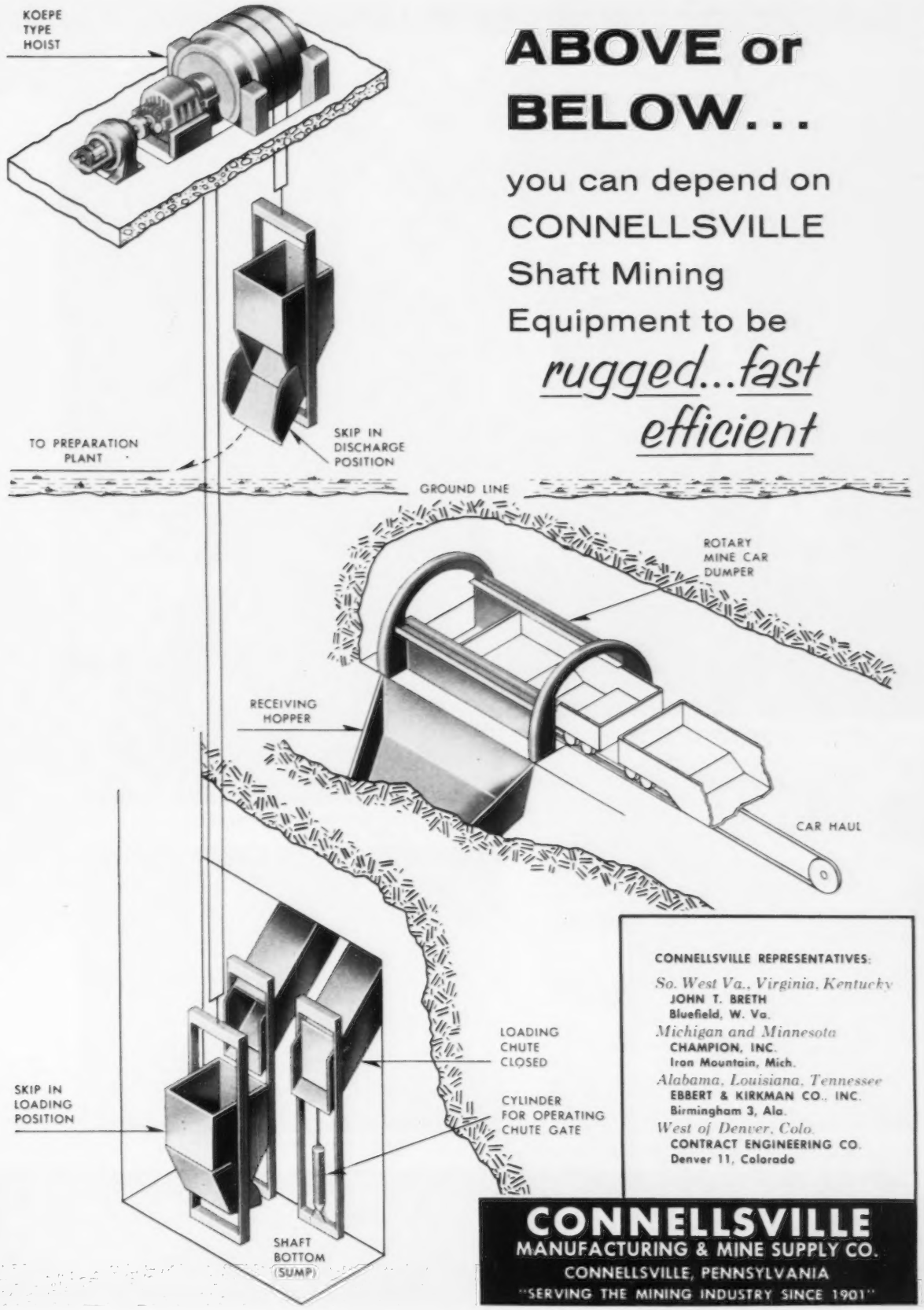

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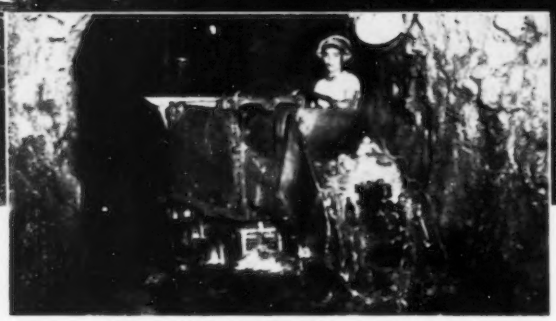

Eimco 12B RockerShovel in water tunnel.

Eimco 635 loading from stockpile.

Eimco 40H in Baltimore water tunnel.

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Every Mine . . .

EIMCO 630 BULLDOZERS REPLACE SLUSHERS

Figure 1. Shows an area that can be cleared in complicated sheave setup for drawing muck to point where additional setup must be made to bring muck to shaft or drawpoint raise. This setup also involves a triple drum hoist or slusher, and moving of at least one sheave block for each blast in the stope.

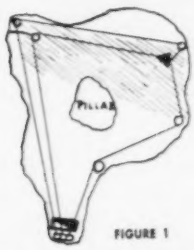

FIGURE 1

FIGURE 2

Figure 2. Shows same area using a simple double drum hoist setup that can remain in position and an Eimco 630 Bulldozer. Effective area cleared is more than double that of the complicated sheave system. Savings in slusher required, wire rope, sheaves, eye bolts and wedges and labor makes the Eimco 630 Bulldozer the most economical investment.

Eimco 630 Bulldozer replaces drag scraper in underground mining operations.

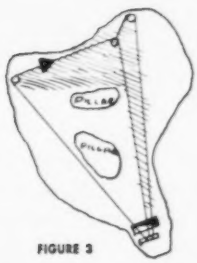

FIGURE 3

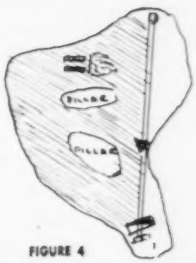

FIGURE 4

Figure 3-4. The same technique applies in Figures 3 and 4 as in 1 and 2 - the same savings can be affected. The difference in this illustration is that no matter how effectively are the sheave blocks arranged, the blind spots can only be covered by drilling another hole and moving a tail sheave. Many operations of this nature where total haul distance does not exceed 150' have eliminated scrapers and slusher hoists entirely.

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B - 335

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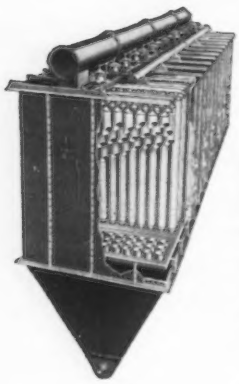

PRODUCTS: Automatic and Semi-Automatic Bag Type, H. E. L. S. Cyclone or Centrifugal Type, Hydraulic Type Dust and Fume Collectors, Cement Air Cooling System, Self-Contained or Portable Bag and Filter Type Units, Exhaust Fans . . . All designed and fabricated by our own shops.

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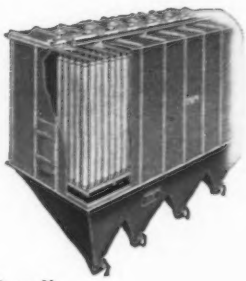
Norblo Standard Bag Type

For intermittent service, as fan and unit must be shut down for cleaning, usually at noon hour and end of working day. Electrical or compressed air shaking and cleaning mechanism. Basic unit has 40 bags 6" diameter, 8' 3" long, 480 square feet cloth area. In both Standard and Automatic bag types made by Norblo, extra large hoppers provide air expansion space resulting in great drop in air velocity and a maximum degree of dust separation by gravity before passing upward for final filtering.



Norblo Hydraulic

A high efficiency, wet type collector, for separation of dust mixed with smoke or fumes. In most installations the Hydraulic unit is used with a Norblo Cyclone collector, thus reducing the amount of wet sludge to be handled. There are no moving parts. Filter beds are coke or high-fired ceramic tubes, light in weight and kept in motion by ascending air stream so that beds are self-cleaning. Built in 11 standard sizes with capacities up to 26,000 cfm.

Norblo H. E. L. S. Centrifugal

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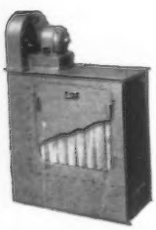

Norblo Portable Units

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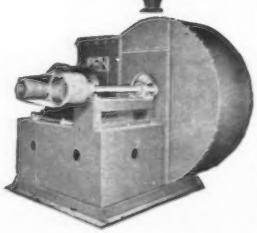

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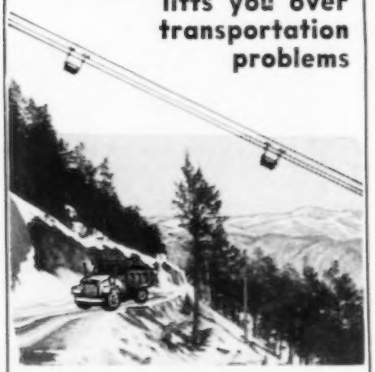

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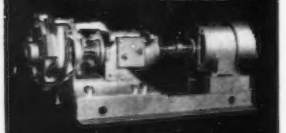
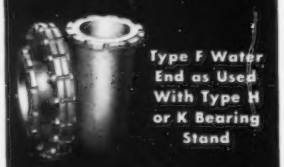
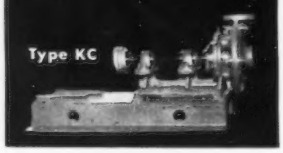

Type HR


Type F Water End as Used With Type H or K Bearing Stand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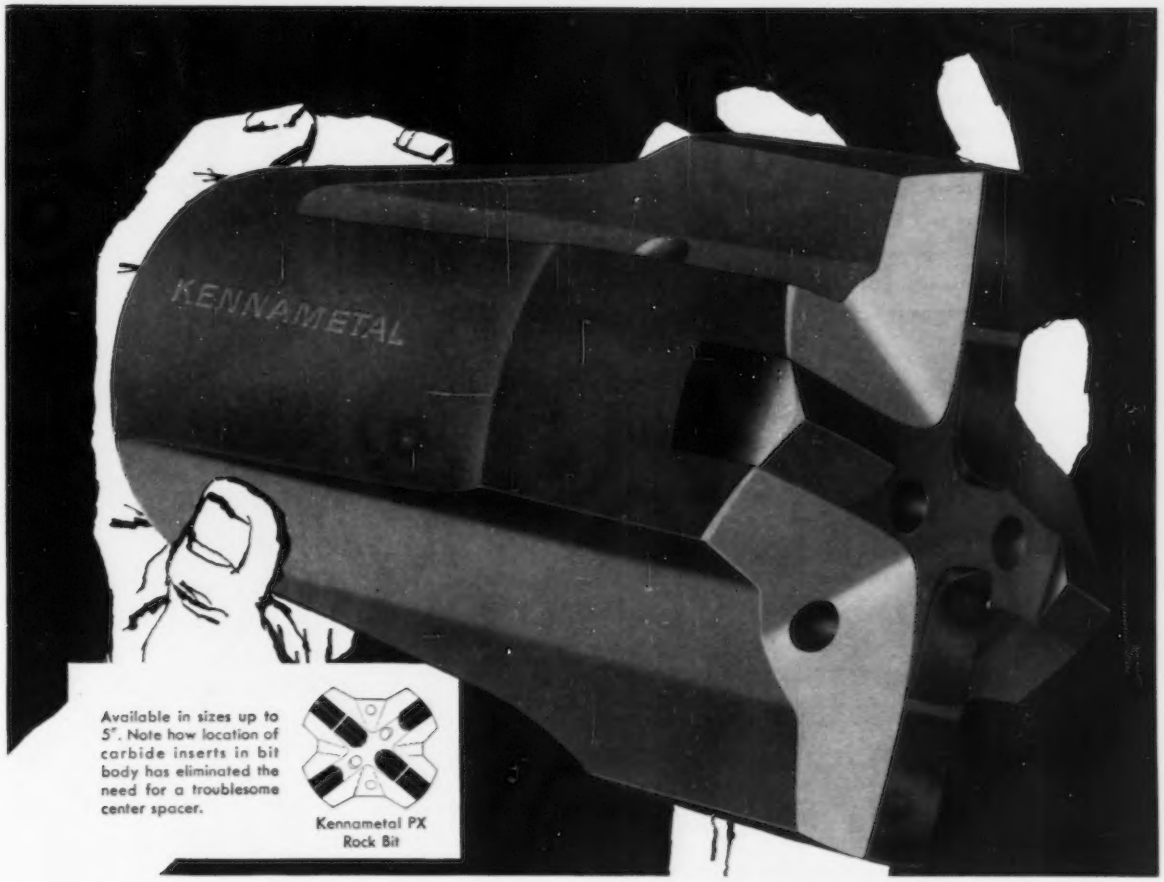

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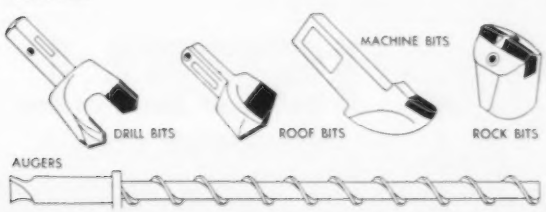

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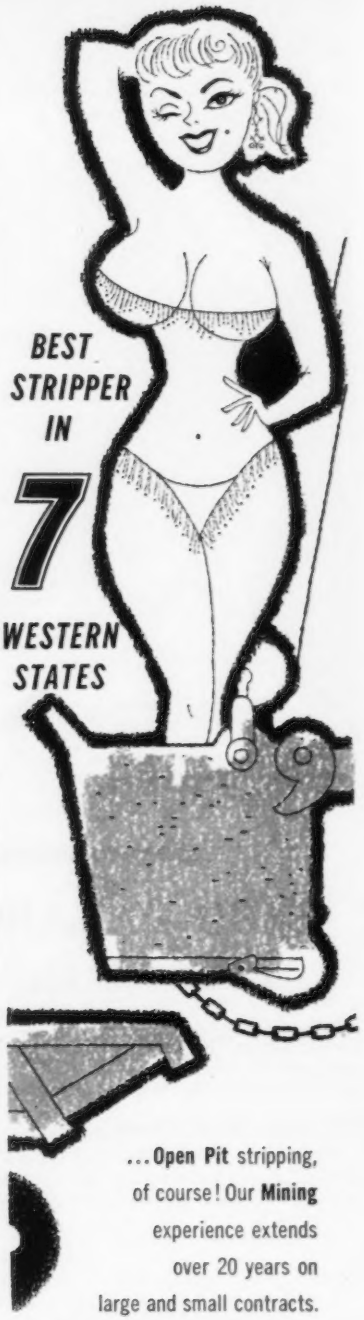

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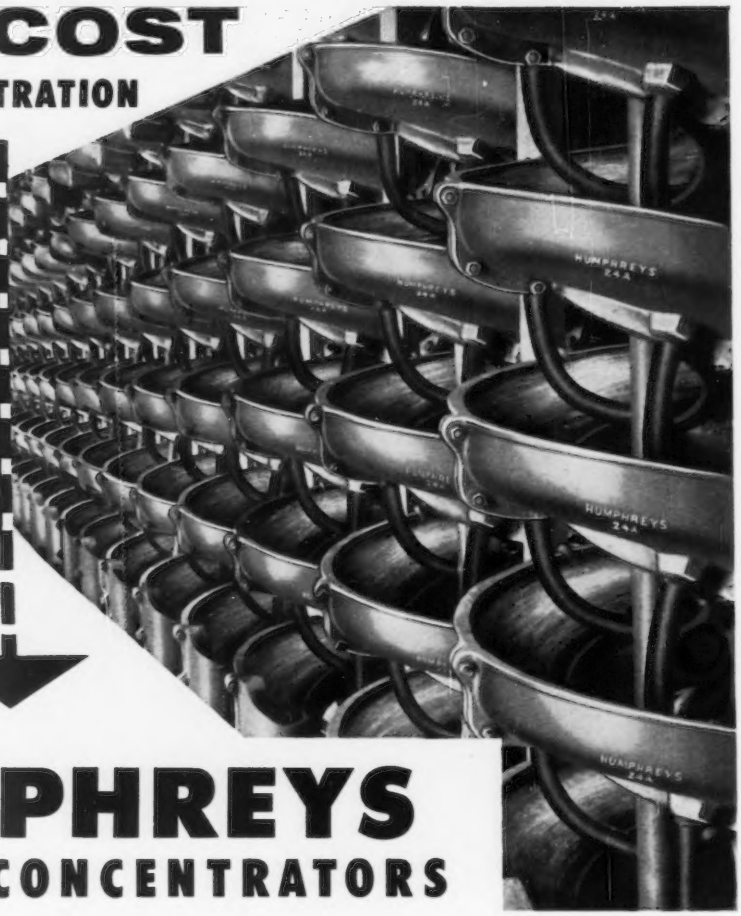

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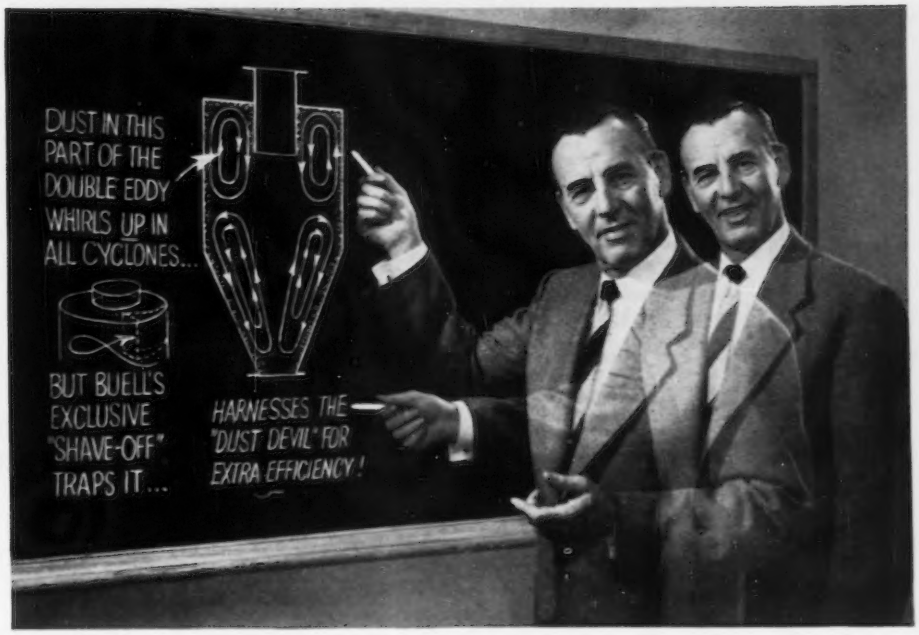
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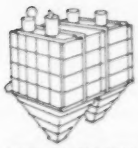

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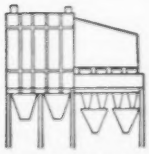

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"Push In and Pull Out" ventilation is becoming increasingly popular in mines because of its effectiveness. A B C Tubing of **NEOLON**—the amazing, tough, rip-proof neoprene coated nylon fabric—gives longer service with maximum economy. Regular **NEOLON** Flexible Tubing for blowing in fresh air and Wire Reinforced **NEOLON** Tubing for exhausting fouled air. All standard diameters, in any length. Both types easy to couple and choice of "S" hook or Rivet Hook suspension. A B C Tubing is the most complete line. Send for Catalog 158.

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220 S. Buffalo St., Warsaw, Indiana

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FOR MANUAL APPLICATION

THIS HARD-FACING ROD	FOR THESE CONDITIONS	FOR THIS EQUIPMENT	APPLI-CATION
VICTORTUBE	Severe abrasion	Ripper and ditcher teeth, dredge cutter blades, posthole augers, oil field tools, pug mill knives	ACETY. AC-DC ELEC.
VICTORTUBE BARE-30-DOWN	Severe abrasion	Agricultural tools	ACETY. ONLY
VICTORTUBE "SPECIAL"	Abrasion, severe impact	Oil field bits, rock bits	ACETY. ONLY
VICTOR TUNGSMOOTH	Thin cutting	Augers, bits, blades, screw conveyors, farm tools	ACETY. AC-DC ELEC.
VICTORITE	Earth abrasion, sliding friction	Farm tools, earthmoving rigs	ACETY. AC-DC ELEC.
TUBE VICTORITE	Abrasion, impact	Plow points and farm tools	ACETY. AC-DC ELEC.
VICTORITE 1	Corrosion, heat, abrasion	Chemical and food machinery, arbors, screw conveyors, soaking pit tongs	ACETY. AC-DC ELEC.
VICTORITE 6	Red heat, impact corrosion, abrasion	Forming dies, exhaust valves, cams, steam valves	ACETY. AC-DC ELEC.
VICTORITE 12	Heat, abrasion, impact	Saw blade inserts and other critical applications	ACETY. AC-DC ELEC.
VICTORITE CARBON ARC	High abrasion, thin deposit	Plowshares, lister shares, sweeps	CARB. ARC ACETY.
VICTORALLOY	Abrasion, severe impact	Crushers, dredge pumps and cutters, dipper teeth, tampers, rollers, idlers	ACETY. AC-DC ELEC.
VICTORALLOY #1	High abrasion, medium impact	Bucket lips, rock crushers, muller tires, gyratories	ACETY. AC-DC ELEC.
VICTORALLOY "A"	Angular shock, extreme impact, build-up	Clutch parts, gears, crusher plates, gyratory mantles, build-up for hardfacing	AC-DC ELEC. ONLY
VICTORALLOY "B"	Heavy impact, moderate abrasion	Tractor rollers and sprockets, shovel pads, plates, idlers, etc.	AC-DC ELEC. ONLY
VICTORALLOY "C"	High abrasion, moderate shock and impact	Tractor grousers, pressure rolls, crusher segments, roll crusher teeth	AC-DC ELEC. ONLY
VICTOR MULTI-PASS	Impact, compression, build-up	Drive sprockets and tumblers, rollers, idlers, churn drills, clutch jaws	AC-DC ELEC.

What's proper Victor rod for your hardfacing needs?

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FOR AUTOMATIC & SEMI-AUTOMATIC APPLICATION

THIS TYPE	FOR THESE CONDITIONS	ON THIS KIND OF EQUIPMENT
#0	High abrasion, medium impact	Crusher rolls, rock crushing equipment
VA #1	Abrasion, medium impact	Crushers, scraper blades
VA #2	Abrasion, impact, Multi-pass application	Steel mill applications, tractor idlers
VA #3	Abrasion, light impact	Mill guides, crushers, dredge bushings
VA #4	Multiple layer build-up	Tractor rollers and idlers, sheave wheels
VA #5	Heavy impact, abrasion	Tractor rollers, idlers, mine car wheels, sheave wheels
VA #6	Medium abrasion, high impact	Crane wheels, drums, roll necks
VA #7	Abrasion, high impact	Build-up for hardfacing, mine car wheels
VA #8	Abrasion, high impact	Roll crushers, scraper and grader blades, tool joints
VT #60	Extreme abrasion	Tool joints, grader blades, scraper blades
Mo-Mn	Manganese build-up	Wherever manganese build-up needed

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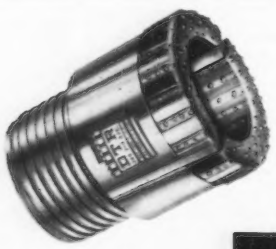

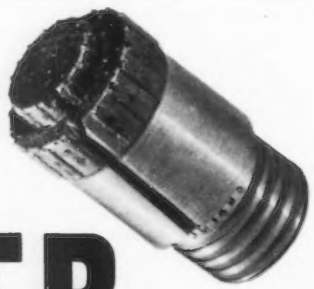

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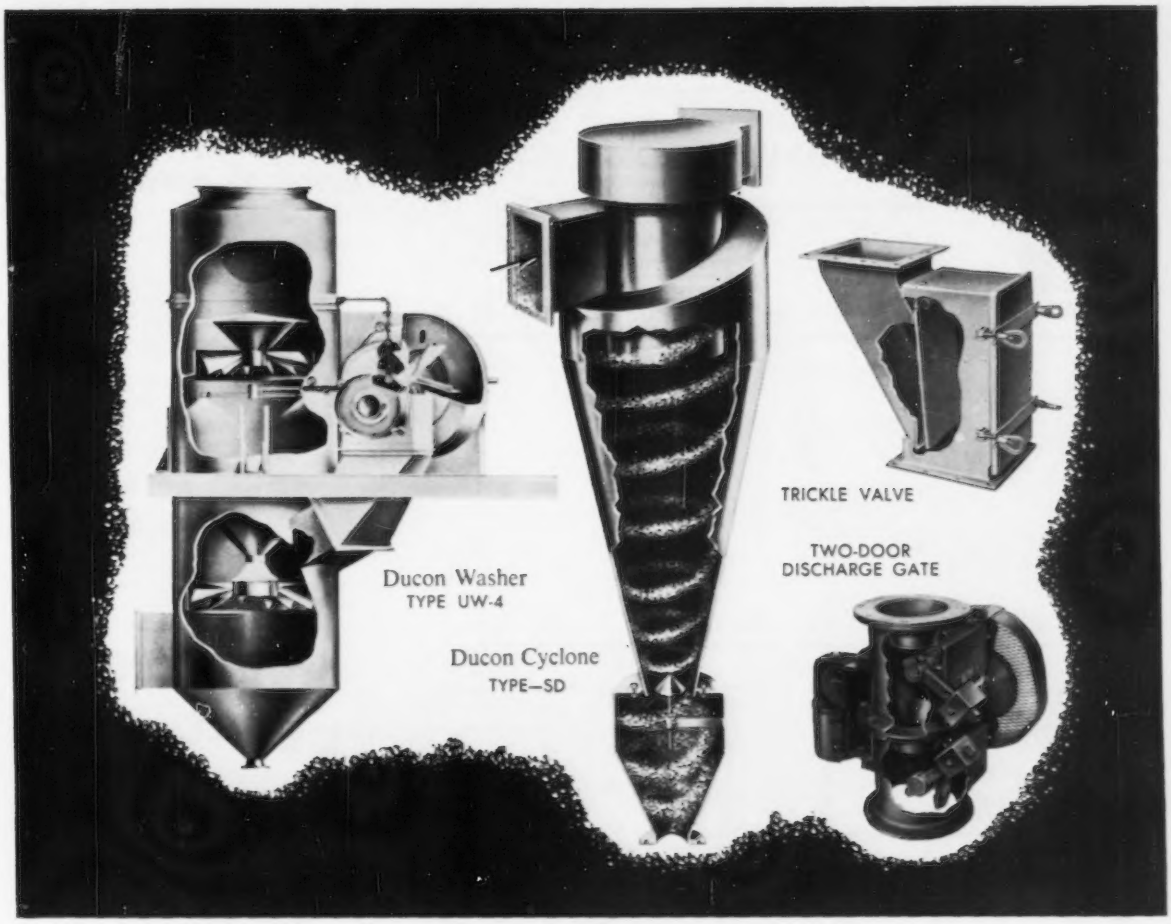

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high efficiency dust control equipment

Ducon High Efficiency Dust Collectors have been giving exceptional service for over 30 years in a wide variety of industrial applications, including rotary drying, pneumatic conveying, grinding, fluid bed processes, calcining and many others.

Duclones — high efficiency cyclone collectors — have six unique design features which contribute to their excellent performance and wide acceptance: small diameter for high efficiency; helical roof to prevent turbulence; steep cone to improve separations; dust trap for efficient dust removal; vortex shield to prevent reentrainment; and scroll outlet for low resistance gas exit.

Duclones are available in multiple units and in stainless steel, ceramic-lined and other special constructions.

Ducon Washers, centrifugal and dynamic, provide maximum efficiency and long service life in wet dust control processes. Washers are available in several types and in package units with fan, exhauster and dewatering tank. Ducon Washers offer constant air capacity, low pressure drop, low water consumption, fire and explosion-proof, non-freezing, sturdy construction.

Valves & Gates — Four types of gas-tight, free-discharge mechanisms are available: Two-door discharge gate, rotary gate, non-sticking slide gate and the patented trickle valve. Write for bulletins.

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TUNGSTEN CARBIDE ROK-BITS

FOUR-POINT CROSS TYPE ROK-BIT

STANDARD STYLE

*CUTAWAY STYLE
H also designated as 116H
D also designated as 119D

Thread Gauge	A	F	H	D	G	113	121	Type II	Type III	200	400	600	700	1000	J5.5	J7.5
1⅛	X					X										
1⅜		X				X				X						
1½		X	X			X				X						
1⅝		X	X			X				X						
1¾			X	X						X						
1⅞			X	X						X	X					
2			X	X				X		X	X					
2⅛			X	X				X		X	X					
2¼			X	X			X	X		X	X					
2⅜				X			X		X		X					
2½				X	X		X		X		X	X				
2⅝				X	X		X									
2¾				X	X		X					X			X	
3				X	X		X		X			X	X		X	
3¼				X			X									
3½												X	X		X	X
4													X		X	X
4½														X		X
5														X		X

CHISEL TYPE

Other threads on special order

BIT SIZE	THREAD DESIGNS AVAILABLE			
1½"		F	H	
1⅝"		F	H	
1¾"			H	D
1⅞"			H	D
2"			H	D
2⅛"				D
2¼"				D

"X" TYPE
(for long hole drilling)

BIT SIZE	THREAD DESIGNS AVAILABLE			
1⅞"	#400			
2"	#400			
2⅛"	#400			
2¼"	#400			
2⅜"	#400			
2½"	#400	#600		
2¾"		#600		
3"		#600		
3½"		#600 K		J7.5
4"		#600 K		J7.5
4½"				J7.5

CROSS TYPE
(for long hole drilling)

BIT SIZE	THREAD DESIGNS AVAILABLE	
2¾"	#600	
3"	#600	
3½"	#600	J7.5
4"	#600	J7.5

TAPER TYPE

Brass Shim Furnished with Each Bit

FOR USE ON ⅛" STEEL		FOR USE ON 1" STEEL	
TAPER SPECIFY	BIT SIZE	TAPER SPECIFY	BIT SIZE
A-47-12"	1¼"	A-47-12"	1½"
A-47-12"	1½"	A-B-47-46-12"	1½"
A-47-12"	1½"	A-B-47-46-12"	1¾"

ROK-MASTER ROK-BIT

HOLE-MASTER ROK-BIT

BIT SIZE	THREAD DESIGNS AVAILABLE	
6"	2" x 3" No. 7 A.P.I. Thread	For use with "QuarryMaster drill"
6"	Spline	For use with "Down the Hole drill"
6½"	Spline	For use with "Down the Hole drill"
7"		

E&MJ'S BUYERS' GUIDE Is Right Up-to-the-Minute

The Buyers' Guide Section in this Guidebook is the most comprehensive listing of manufacturers available in the industry. Product listings are based on information obtained from all known manufacturers serving the field—a company-by-company check by the E&MJ editors just for this 1958 edition.

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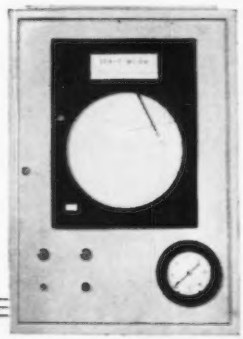
the complete control system...



for conveyor belt
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CON-O-WEIGH is a highly accurate continuous belt scale for weighing free-flowing bulk materials. It is engineered as a complete control system for many of industry's most technical feeding, weighing, blending and totalizing operations. CON-O-WEIGH is also widely used for simple weighing and recording routines on a tons-per-hour basis.

For your specific bulk material weighing problem get the facts on this rugged, easy to install machine.

Write for free bulletin 57-A

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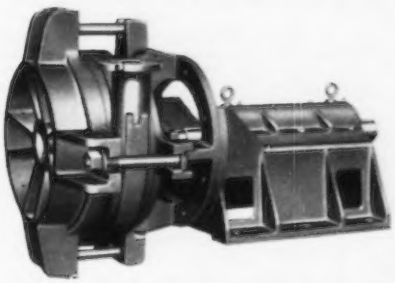
- ***Ideal for Flotation Mill Service***

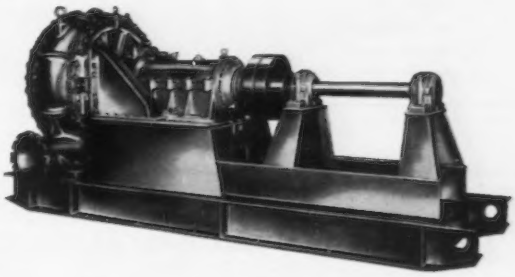


MORRIS type "RX" SLURRY PUMP

. . . for continuous 24-hour pumping of Ore Slurries, Tailings, Concentrates, Abrasive Mixtures

- **Simple design.** No internal studs or bolts—no troublesome internal joints and fits.
- **Easily dismantled.** Impeller and shaft sleeve reached simply by removing 4 external bolts.
- **Abrasive resistant.** Casing furnished in large variety of wear-resistant materials.
- **Large hydraulic passages.** Permit low velocities, minimizing wear and frequency of renewals.
- **Drive-side suction.** Stuffing box troubles practically eliminated under conditions of high suction pressure, high vacuum or high suction lift.

Widely used in both metallic and non-metallic mines and mills. Sizes 2" to 8". Write for Bulletin No. 185.



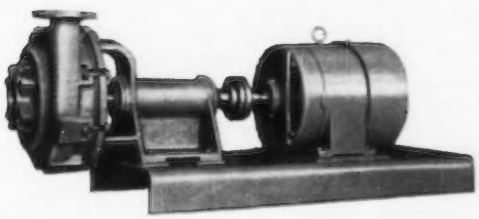
MORRIS types "GA" and "GAF" HEAVY DUTY DREDGE PUMPS

Small high speed or large low speed units for pumping abrasives against high heads.

- **Giant shaft** of high-grade steel withstands vibration, handles shock loads easily.
- **Suction opening** is larger than discharge for handling higher percentage of solids at greater depths without excessive vacuum on suction.
- **Oversize antifriction bearing assembly**
- **Economical impeller design.** With external cleaning vanes on both sides. Enlarged suction shroud seals on nose.
- **Heavy volute casing** with extra heavy sections at points of maximum wear. Discs covered with heavy renewable liners . . . openings are of same size for right or left hand assembly.

Wearing parts furnished in special alloys. Sizes 6" to 36". Send for Bulletin No. 184.

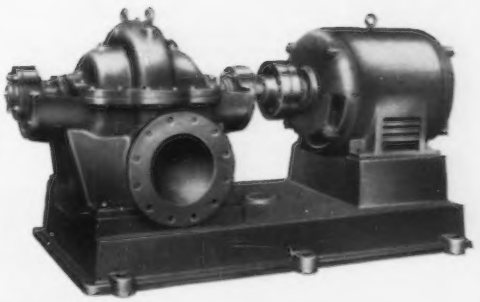
MORRIS



MORRIS TYPE, BA SLURRY PUMP

For continuous 24 hour duty in abrasive process handling.

- **Small, high speed** slurry pump with built-in abrasive resistance.
- **Available in cast-iron,** Ni-hard or 316 stainless steel.
- **Features** renewable suction liner and semi-open impeller.
- **Simple design,** rugged construction, easy to dismantle and re-assemble.
- **Sizes range from 1" to 4".**



MORRIS Double-Suction Horizontally-Split Centrifugal Pump

For Drainage and General Service

- **Floating Sealing Rings** adjust concentrically to impeller speeds.
- **Extra-heavy shaft** of tough, hard alloy steel.
- **Upper part** of horizontally-split casing easily removed without disturbing suction or discharge piping.
- **Heavy-duty precision ball bearings** mounted in dust-and-moisture-proof housings.

May be connected in series for higher heads. Sizes: 2" to 220". Send for Bulletin No. 170.

Typical Installation on Main Haulage

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- Low in Cost.
- Easy to Install
- Increases Production.

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TRACK SWITCH THROWER ELECTRICALLY OPERATED

This modern track switch is thrown swiftly and safely by motormen as they sit in their cabs. It saves time and money, and is fool-proof and dependable!

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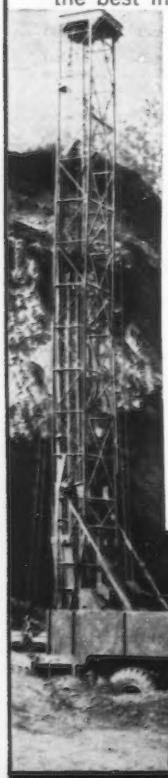

- Gardner Denver AM6 Mole Dril
- Timken 6½" carbide insert bits
- International Harvester Truck
- Cummins Diesel Engine
- Gardner-Denver WBJ Compressor, 600 CFM at 100 PSI
- Keystone Franks Rotary Mole Drilling Machine

While we DEMONSTRATE what we can do, we cut your drilling costs at the same time. Phone or write us for a DEMONSTRATION on your quarry, mine, road or construction job.

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MOLE DRIL DOWN THE HOLE GUN with Timken threaded carbide insert rock bit

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for the MINING INDUSTRIES

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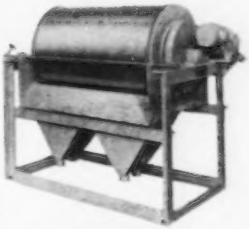
Stearns offers complete laboratory research facilities to help you solve your separation and purification problems. This includes analysis to determine the feasibility of magnetic separation, testing of sample material and recommendation of specific equipment for desired results.

Wet-Drum Separator for Taconite Concentration



The new Stearns Type WPD magnetic separator is a powerful wet-drum, permanent magnet unit designed for cobbing and roughing in taconite concentrations.

Specially designed magnet has a deep, powerful field, and provides correct flux distribution for positive transport of the collected magnetics to the discharge point. These and many other special features put the WPD separator in a class by itself for fast, low-cost taconite recovery.

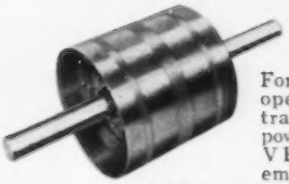
Type K High-Intensity Gravity Induction Magnetic Separator

Stearns Type K magnetic separator provides an intensely powerful magnetic field which attracts very feebly magnetic particles. That is why the "K" has proved highly successful in purification and concentration application when other methods were either impractical or inadequate.

Users report that this separator has given outstanding results for magnetically cleaning or concentrating materials ranging in size from 10 to 200 mesh. Capacity ranges from 80 to over 500 lb per hr per inch of feed width. "K" separators are built in 10, 20 and 30-in. feed widths and can be furnished with from 2 to 7 magnetic fields.

Alternating-Polarity, Dry-Drum Separator

Stearns alternating-polarity, dry-drum separators are used for the dry concentration of highly magnetic materials. Because of their alternating-polarity design, they provide an unusually clean, high-grade magnetic product at a comparatively low cost. They are easy to operate, require minimum attention, and are designed for long, trouble-free service. Complete range of sizes and types to fit your needs.



Magnetic Pulleys

For high recovery in cobbing operations or for low-cost tramp iron protection, the powerful new Stearns Indox V Permanent Magnet Pulley* employs a ceramic magnet material in an assembly with radial pole design. This provides performance equal to that of electromagnetic pulleys, but with all the cost-saving advantages of permanent magnet design. Standard sizes to fit most conveyor systems. Electromagnetic types also available.

*Patents Pending

Suspended Separation Magnet

Provides a tremendous pulling force that reaches far down into material on conveyor lines — prevents escape of deeply embedded tramp iron. Coil-wound for continuous duty. Special insulation and stainless steel coil enclosure assure fast heat dissipation. Round or rectangular construction.

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A DIVISION OF THE INDIANA STEEL PRODUCTS COMPANY

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BULLETIN NO	2011-P	701-BP	2061-P	303-DP 1021-P	1031-P

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In picking a DEUTZ AIRCOOLED DIESEL, Getman Brothers joins Longyear, Atlas-Copco and a long list of other American and foreign manufacturers in specifying the world's outstanding aircooled diesel for their equipment. Only DEUTZ has these outstanding features:

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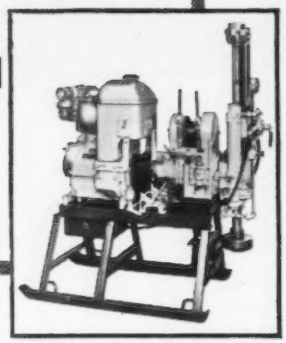
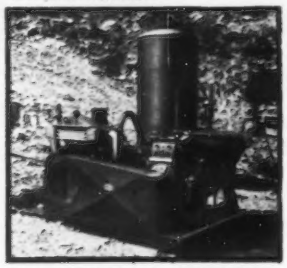


LONGYEAR mineral exploratory drilling machine with Deutz Aircooled Diesel Engine Unit uses Longyear Diamond Core Drill #24. Longyear selected Deutz for its compactness of design, fuel efficiency and excellent service and parts facilities.



Mine installation at Rock Springs, Arizona, uses ATLAS COPCO Compressor CT-6 with Deutz–6 cylinder A 6L/514 engine to assure top running efficiency in all temperatures. The semi-portable compressor provides 320 C.F.M.

PARTIAL SPECIFICATIONS TABLE

MODEL	BHP	RPM
F 1 L 712	10/12	2000/2300
F 2 L 712	20/24	2000/2300
F 3 L 712	30/39	2000/2300
F 4 L 712	40/52	2000/2300
F 6 L 712	60/78	2000/2300
A 2 L 514	28	1800
A 3 L 514	42	1800
A 4 L 514	56/72	1800/2000
A 6 L 514	84/110	1800/2000
A 8 L 614	112/145	1800/2000
A12 L 614	170/220	1800/2000

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Please send me catalogs covering the range I have checked:
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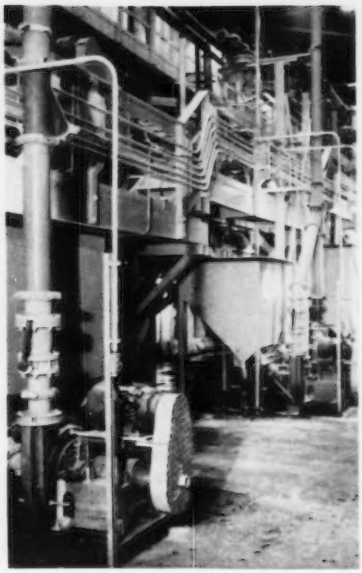
City_____ Zone_____ State_____



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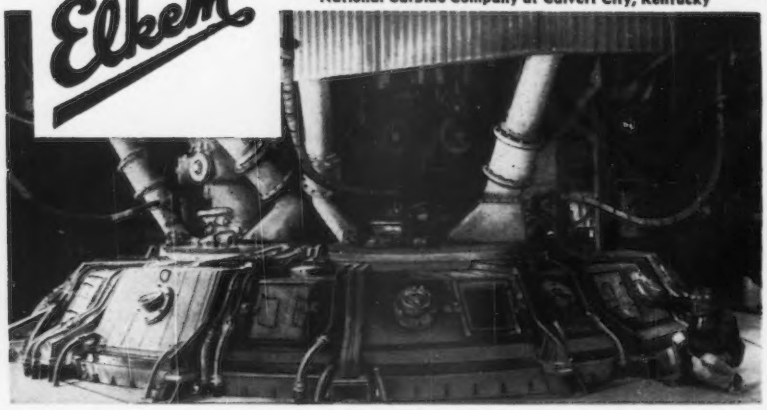
Elkem

Furnace Platform of 1 of 4-39,000 KVA ELKEM CALCIUM CARBIDE Furnaces installed by National Carbide Company at Calvert City, Kentucky



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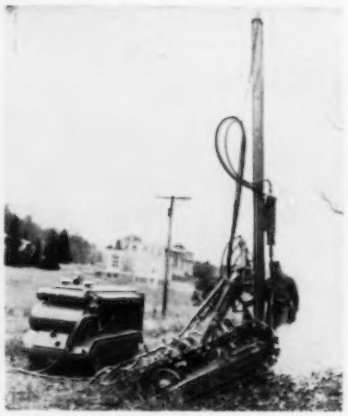

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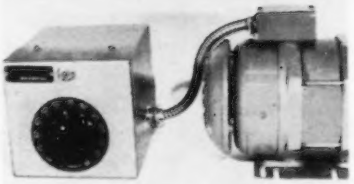

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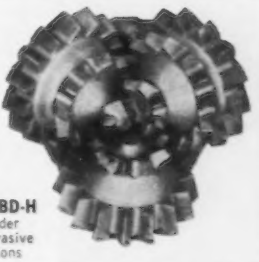

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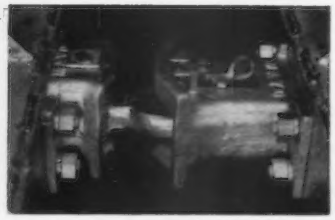

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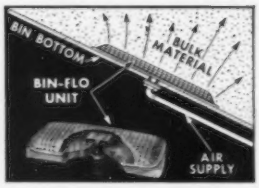

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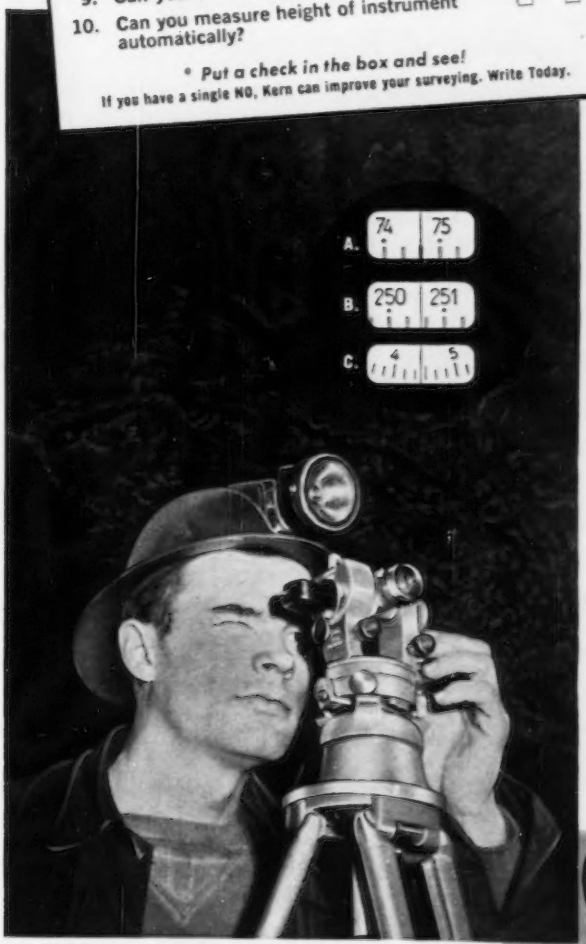

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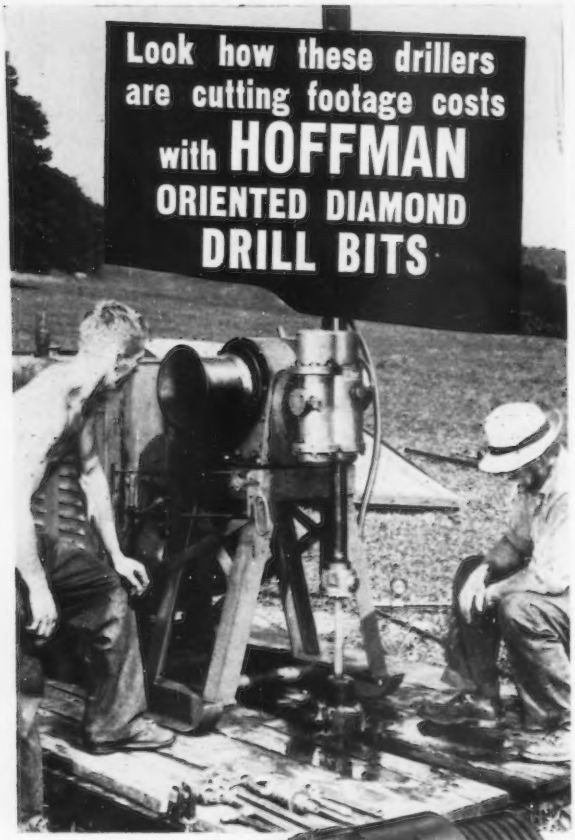

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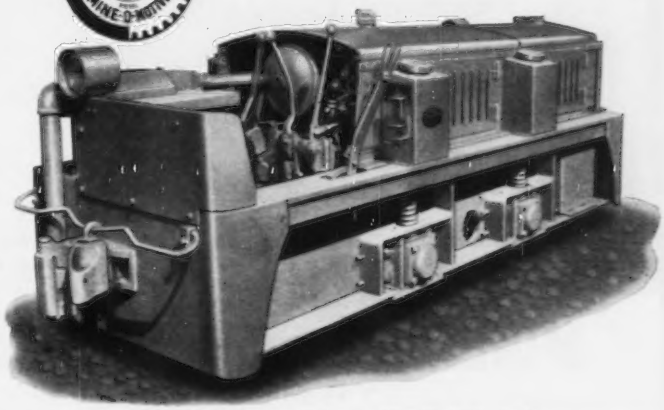

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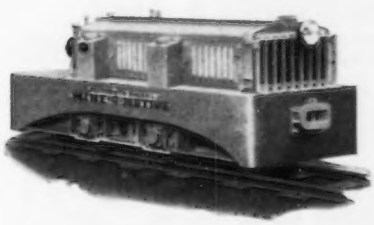

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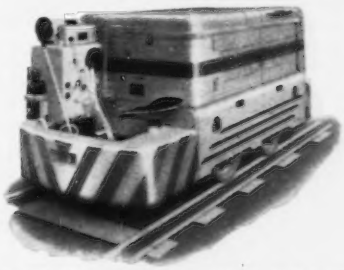

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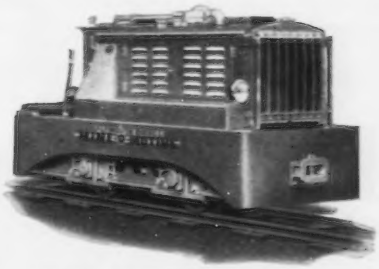

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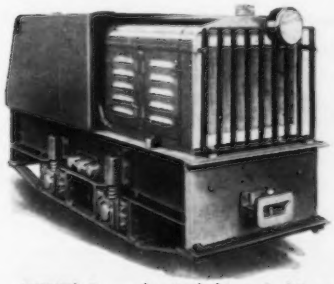

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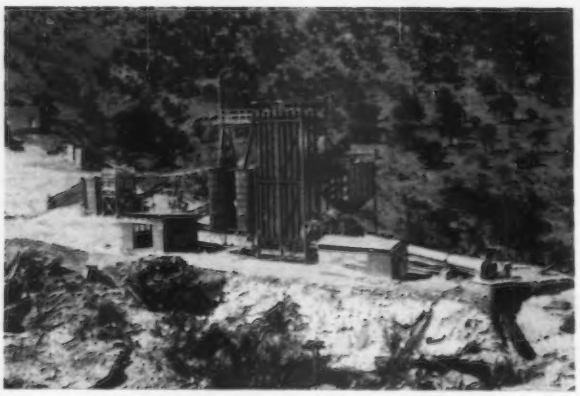

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DART TRUCK COMPANY builds a complete line of trucks—from 10 to 50 Ton payloads. *But*, any model can be built to meet your special haulage requirements.

DART 13S-UG underground shuttle truck with dual controls and through conveyor.

DART's 50 Tonner powered by a 400 or 600 HP Diesel Engine for that big payload.

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TONNAGE ENGINEERED
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POIDOMETERS for ....

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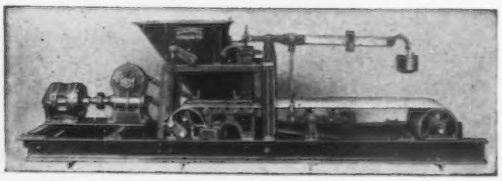
The Schaffer Poidometer is an accurate, durable machine for weighing, feeding and conveying raw materials used in mining, milling, smelting, refining and concentrating industries. Automatic and always dependable, it handles all crushed, granular and pulverized matter.

Proportioning by weight is a function to which the Poidometer is particularly well adapted. In a wide range of applications, batteries of Poidometers regulate and facilitate blending and mixing processes, at the same time keeping an accurate, centralized record of the amounts of materials handled.

SIZE		MAXIMUM CAPACITY*		Maximum Size of Cubes	Available With Motor Operated Gate
Belt Width	Length Scale Platform	Light Duty	Heavy Duty		
6"	2' 0"	2 Tons		Finely ground	No
10"	2' 6"	5 Tons		Finely ground	No
	4' 6" & 6' 0"		10 Tons	Finely ground	No
14"	2' 6"	8 Tons		¼" Cubes	No
	4' 6" & 6' 0"		18 Tons	¼" Cubes	No
20"	2' 6"	15 Tons		1¼" Cubes	No
	4' 6" & 6' 0"		45 Tons	1½" Cubes	Yes
30"	4' 6" & 6' 0"		125 Tons	3" Cubes	Yes
36"	4' 6" & 6' 0"		160 Tons	4" Cubes	Yes
48"	4' 6" & 6' 0"		250 Tons	4½" Cubes	Yes

* Figured on material weighing 100 lbs. per cubic foot. Amount shown is capacity per hour.



THE AUTOMATIC FEEDER-WEIGHER CONVEYOR
Write for Catalog No. 4

MATERIALS HANDLED BY POIDOMETERS

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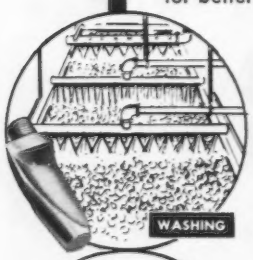
for better washing ... dust control



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- complete choice of types and capacities to fit your job
- greater efficiency with minimum volume of water

Proper distribution and impact for washing ... or proper atomization for dust control without unnecessary wetting ... these are just some of the advantages of having a complete choice of spray nozzle types and sizes to fit your job. For complete information write for Catalog 24.

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choose the **RIGHT MATRIX HARDNESS** for **YOUR JOB!**

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- NICOLITE bits . . 40 to 45° hardness
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Special tungsten alloy powdered metal matrix to meet all drilling conditions. Bit crowns *sintered* onto blank bits in one operation.

Drill bortz and cast in all sizes and prices. Brazilian ballas and carbons. ASCOLITE reaming shells.

Price catalog on request

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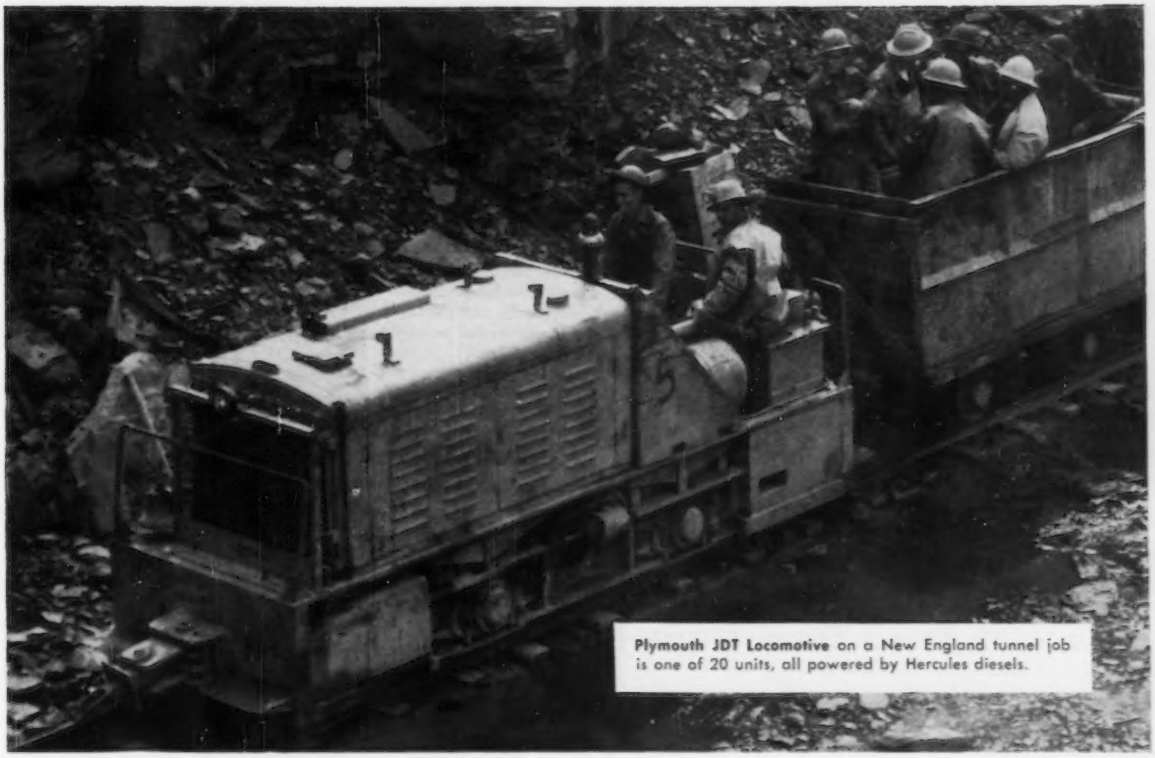
Cables: PROFITABLE, New York

HERCULES DIESELS

Preferred Power Underground



Plymouth JDT Locomotive on a New England tunnel job is one of 20 units, all powered by Hercules diesels.

Hercules Engines for Mine Equipment Have Low Ventilation Requirements

KW-Dart 13S-UG Shuttle Truck has Hercules DRXC as standard power.

National Mine Diesel TorKars offer Hercules DRXC on Type 60 ED; DOOD on 48 ED.

The compactness, dependability and low ventilation requirements of Hercules diesel designs for mine applications are all important factors in their selection by leading manufacturers of underground engine-powered equipment. And the expanded worldwide network of Hercules service facilities assures owners of Hercules-powered equipment prompt, efficient maintenance—wherever they are.

Write for further information on Hercules diesels for mine service.

SPECIFICATIONS

Model	Displ.	HP
DOOD	255	76.5
DJXH	298	96
DRXC	529	136
TCD	895	260

HERCULES

HERCULES MOTORS CORPORATION
Canton, Ohio

HERCULES ENGINES . . . *Sold and Serviced the World Over*

WEIGHTOMETER

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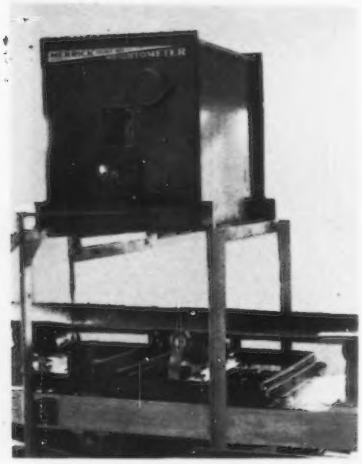
TYPE E

TYPE S

Synonomous with accuracy for weighing high grade Uranium Ores and Copper Concentrates



Heavy Duty High Tonnage

Types E & S Weightometers are universally accepted and depended on for accuracy throughout the entire mining industry. All Units custom designed for each installation.

Our half century of practical & technological advances now provides the intransit bulk material handling user with the latest innovations in mechanical, electronic and pneumatic weighing devices suitable for minimum and maximum tonnage rates.

Optional pneumatic or electrical equipment available with all models that permits complete or partial automation of entire plant systems.

Integral weight & conveying unit available —Inquire about the WSS Weightometer.

Heavy Duty Low Tonnage

MERRICK SCALE MFG. CO.

190 Autumn Street, Passaic, N. J.

Take the guesswork out of interprocess operations and inquire about Merrick's low cost type S-V WEIGHTOMETER

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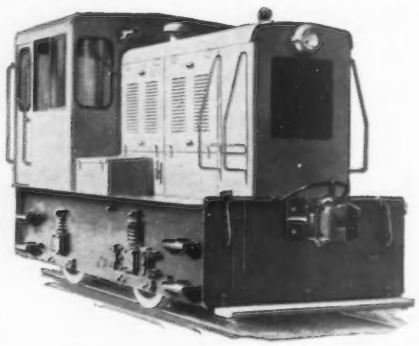
INDUSTRIAL LOCOMOTIVES



5 ton to 40 ton capacity. Track gauges 18" to 66". Powered by diesel or gasoline engines. Hydraulic or electric transmissions. Improved exhaust scrubber.

Unit steel welded cabs and frames. Locomotives designed to meet specific requirements.

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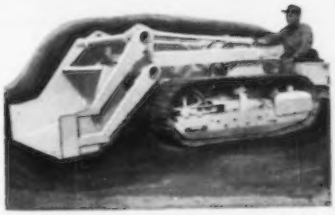
J-6A-58

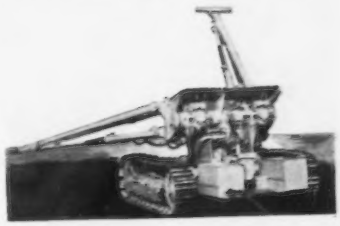
NEW! Air-Driven Loaders and Jumbos Manufactured by Machinery Center



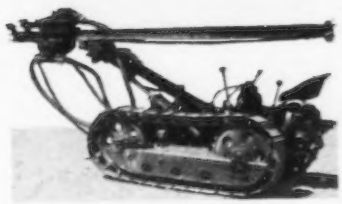
Front-End Loader
Model MC-58-A

◀ **Model MC-58-A—Air-Driven Crawler-Type Front-End Loader Rated ⅝ Cu Yd**—Featuring 15-hp air motor operating through 4-speed transmission, hydraulic bucket control, for loading, dozing or hauling. Two Models available: 42″ high, unloading from ground to 60″ high, width 42″ to 63″.

Model MC-JB2 Crawler-Mounted Drill Jumbo for 2 Hydraulic Jibs—Mounts 2 drills up to 4″, percussion or rotary. Features long feeds; hydraulic controls; heavy, rugged construction; stable, dependable drilling; highly maneuverable. Available for low or high faces, and/or headings, rooms or roof bolting. ▶



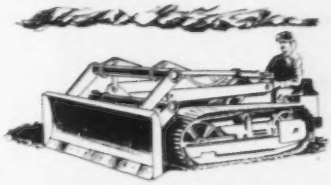
2-Drill Jumbo Model MC-JB2



1-Drill Jumbo
Model MC-JB1

◀ **Model MG-JB1 Crawler-Type Drill Jumbo**—Mounts one drill up to 4½″ size. Features long feed, or rotary drill operation. Designed for headings, rooms, roof bolting or pit work. Easy to modify for vertical or horizontal drilling. Heavy and rugged construction; 45″ high or higher, up to 72″ wide.

Model MC-DA1 Air-Driven Crawler-Type Bulldozer—Features hydraulically controlled lift and adjustable angle, oscillating track, automatic blade leveling by hydraulic valve, 15-hp reversible air motor operating through 4-speed transmission, full power for tough conditions. ▶



Bulldozer Model MC-DA1

Two Models available, 42″ to 63″ wide, 42″ to 48″ high, 72″ to 102″ long, weight 6,000 to 8,000 lb.

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WILFLEY centrifugal PUMPS

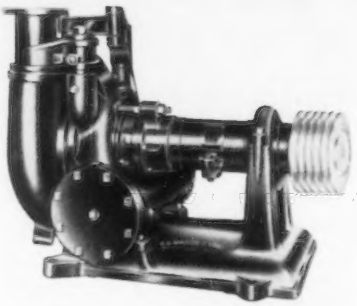
CENTRIFUGAL WILFLEY PUMPS

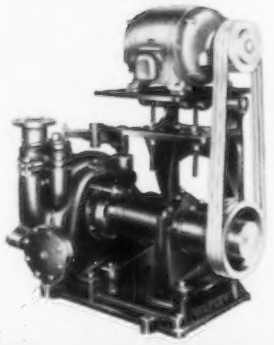
INDIVIDUAL ENGINEERING ON EVERY INSTALLATION

The new patented **WILFLEY MODEL "K"** centrifugal sand pumps are designed for maintained high efficiency in rugged service and trouble-free operation. They combine the original WILFLEY principles with new improvements developed through years of engineering experience.

BELT DRIVEN, overhead V-belt driven and direct driven WILFLEY Model "K" pumps available in 1", 1½", 2", 2½", 3", 4", 5", 6", and 8" discharge sizes with capacities to 3000 GPM and heads as high as 200'.

WILFLEY SAND PUMPS may be fitted with interchangeable electric furnace alloy iron or rubber covered wear parts to best meet the requirements of each pumping installation. The WILFLEY wear part design is ideal for rubber covering as ample clearance around the runner assures a practical and dependable rubber lined pump. Wherever you have a solids transfer job specify the WILFLEY Model "K" sand pump—for continuous, trouble-free performance, simple installation and stepped-up production.



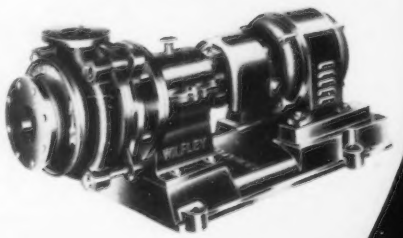


Wilfley Sand Pump
"COMPANIONS IN ECONOMICAL OPERATION"
Wilfley Acid Pump

For Acids, Corrosives, Hot Liquids & Mild Abrasives

The new **WILFLEY MODEL "AF"** acid pump is famous for efficiency and dependability. Actual production-line records show worthwhile dollar savings in stepped-up performance and low-cost operation. Every day, in modern chemical plants the world over, WILFLEY Acid Pumps move hard-to-handle solutions on a trouble-free, round-the-clock schedule. Available in 5 to 3,000 GPM capacities with heads from 15 to 200' and higher.

WILFLEY PACKINGLESS Acid Pump is available with wetted pump parts of any machinable alloy as well as plastics. This versatility of materials, as well as rugged heavy-duty construction and sound mechanical design, combine with the unique WILFLEY principles to make this an ideal pump for any corrosive service.



Let our engineers solve your pumping problems.

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For all products and services, use...

E&MJ's 1958 BUYING DIRECTORY

THE LISTINGS IN THE FOLLOWING PAGES were compiled by the editors of *E&MJ* as a handy spot-reference of modern equipment and services that will help you do your job more efficiently and profitably.

The Buying Directory is divided into three major sections:

1. **Classification of Products**
2. **Manufacturers' Index**
3. **Advertisers' District Sales Offices**

Classification of Products. In this index, more than 2,000 firms in the mining industry have listed just what equipment or services they wish to offer. This listing has been alphabetized both by item and company and cross-indexed to help you to quickly and easily find the product or service you want.

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1. Classification of Products ►

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INDIVIDUAL ENGINEERING ON EVERY INSTALLATION

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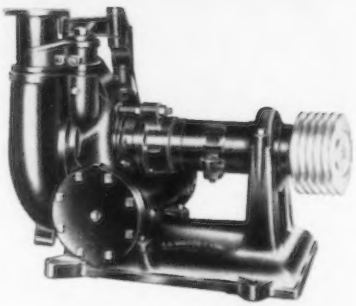

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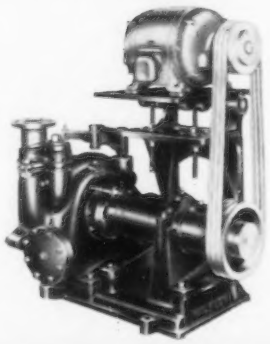

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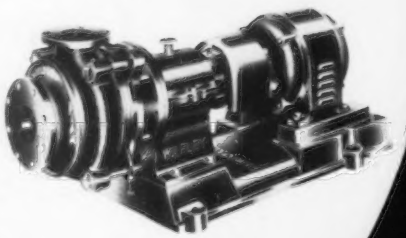

Let our engineers solve your pumping problems.

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THE NETHERLANDS,
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Wassenaarsche Weg 40,
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1. Classification of Products ►

1. Classification of Products

A

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Aluminum Co. of America
American Coldset Corp.
Bay State Abrasive Products Co.
Chicago Wheel & Mfg. Co.
Diamond Drill Carbon Co.
Electro Refractories & Abrasives Corp.
Exolon Co.
HOFFMAN BROS. DRILLING CO.
Linde Co.
Macklin Co.
Minnesota Mining & Mfg. Co.
Norton Co.
Pettinos, Inc., George F.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Precision Grinding Wheel Co., Inc.
Simonds Worden White Co.

ACETYLENE GENERATORS—see Gas Generators

AERATORS

American Water Softener Co.
Bartlett & Snow Co., C.O.
BIN-DICATOR CO.
Booth Co.
Cochrane Corp.
Dorr-Oliver, Inc.
EIMCO CORP.
Graver Water Conditioning Co.
Infilco, Inc.
Jeffrey Mfg. Co.
Johnson Co., C.S.
LINK-BELT CO.
Permutit Co., Div. Pfaudler Permutit Inc.
Penberthy Mfg. Co.

AERIAL EXPLORATION SERVICE—see Contractors

AERIAL TRAMWAYS & CABLEWAYS—also see Excavators, Dragline Tower

Lidgerwood Industries, Inc.
NORDBERG MFG. CO.
RIBLET TRAMWAY CO.
Roebling's Sons Corp., John A. Subsidiary of Colorado Fuel & Iron Corp.
SAUERMAN BROS., INC.
Skookum Co., Inc.
Superior-Lidgerwood-Mundy Corp.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
Yara Engineering Corp. Interstate Equipment Div.

AGGLOMERATING EQUIPMENT & SUPPLIES—see: Nodulizing, Sintering; Water Clarification

AGITATORS & MIXERS, GAS

Mixing Equipment Co.
Turbo-Mixer Div. General American Transportation Corp.

AGITATORS & MIXERS, LIQUIDS & SLURRIES—also see: Flotation Machines; Scrubbers

Abbé Engineering Co.
Atlantic Tank Corp.
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EIMCO CORP.
Fisher Scientific Co.
Galigher Co.
HARDINGE CO., INC.
Hirsch Bros. Machy. Co.
Infilco, Inc.
Mixing Equipment Co.
Moran Engineering Co.
Morse Bros. Machinery Co.
Ogden Iron Works
Patterson Foundry & Machine Co.
Philadelphia Gear Corp.
Troy Engine & Machine Co.
Turbo-Mixer Div. General American Transportation Corp.
WESTERN MACHINERY CO.

AIRCRAFT

Auto-Lite Battery Corp.
Beech Aircraft Corp.
Bell Helicopter Corp.
Cessna Aircraft Co.
Goodyear Tire & Rubber Co.
Hiller Helicopters
Johnson Aircraft Co.
Quaker Rubber Div. H. K. Porter Co., Inc.
Sikorsky Div. United Aircraft Co.
Spartan Air Services
U. S. Rubber Co. Mechanical Goods Div.

AIR COMPRESSORS, MOVABLE & PORTABLE

Acme Machinery Co.
Allis-Chalmers Mfg. Co Industries Group
American Brake Shoe Co.
Atlas Copco Eastern, Inc.
Atlas Copco Pacific, Inc.
Beach-Russ Co.
Binks Mfg. Co.
Cardox Corp. Hardsocg Div.
Chicago Pneumatic Tool Co.
Curtis Manufacturing Co.
Davey Compressor Co.
Equitable Powder Mfg. Co.
Essick Manufacturing Co.
Fuller Co., Subsidiary General American Transportation Corp.
GARDNER-DENVER CO.
Hales Co., W. M.
Holman Bros.—Canada Ltd.
INGERSOLL-RAND CO.
Jaeger Machine Co.
Joy Mfg. Co.
Le Roi Div. Westinghouse Air Brake Co.
O.K. Machinery Div. John C. Motter Printing Press Co.
Olin-Mathieson Chemical Corp. Explosives Div.
Schramm, Inc.
Schroeder Brothers Corp.
Smith & Co., Gordon
Westinghouse Air Brake Co.
Worthington Corp.

AIR COMPRESSORS, ROTARY

Allis-Chalmers Mfg. Co. Industries Group
Beach-Russ Co.
Chicago Pneumatic Tool Co.
Davey Compressor Co.
Fuller Co., Subsidiary General American Transportation Corp.
GARDNER-DENVER CO.
INGERSOLL-RAND CO.
Jaeger Machine Co.
Joy Mfg. Co.
Nash Engineering Co.
Pickard Industries, Inc. Central Mines Supply Co., Div.
Roots-Connersville Blower Div. Dresser Industries, Inc.
Wagner Electric Corp.
Le Roi Div. Westinghouse Air Brake Co.
Worthington Corp.

AIR COMPRESSORS, STATIONARY

Acme Machinery Co.
Allis-Chalmers Mfg. Co. Industries Group
American Brake Shoe Co.
Atlas Copco Eastern, Inc.
Atlas Copco Pacific, Inc.
Binks Mfg. Co.
Cardox Corp. Hardsocg Div.
Carrier Corp.
Chicago Pneumatic Tool Co.
Cooper-Bessemer Corp.
Curtis Manufacturing Co.
Davey Compressor Co.
Essick Manufacturing Co.
Fuller Co., Subsidiary General American Transportation Corp.
GARDNER-DENVER CO.
Hales Co., W. M.
Holman Bros.—Canada Ltd.
Imperial-Cantrell Mfg. Co.
INGERSOLL-RAND CO.
Jaeger Machine Co.
Joy Mfg. Co.
Le Roi Div. Westinghouse Air Brake Co.
Lima Electric Motor Co.
Nash Engineering Co.
Olin-Mathieson Chemical Corp. Explosives Div.
Pennsylvania Pump & Compressor Co.
Schramm, Inc.
Smith & Co., Gordon
Spencer Turbine Co.
Westinghouse Air Brake Co.
Westinghouse Air Brake Co. Ind. Products Div.
Worthington Corp.

AIR COMPRESSORS AFTERCOOLERS

Atlas Copco Pacific, Inc.
Binks Mfg. Co.
Chicago Pneumatic Tool Co.
Curtis Manufacturing Co.
GARDNER-DENVER CO.
INGERSOLL-RAND CO.
Johnson Corp.
Joy Mfg. Co.
Pennsylvania Pump & Compressor Co.
Ross Heat Exchanger Div. American Standard
Schramm, Inc.
Westinghouse Air Brake Co.

AIR LINE OILERS

Acme Machinery Co.
Atlas Copco Pacific, Inc.
Chicago Pneumatic Tool Co.
Davey Compressor Co.
EIMCO CORP.
GARDNER-DENVER CO.
Hayes Steel Products Ltd.
INGERSOLL-RAND CO.
Joy Mfg. Co.
Schramm, Inc.
Thor Power Tool Co.
Wilkerson Corp.
VICTOR EQUIPMENT CO. ALLOY ROD & METAL DIV.
Le Roi Div. Westinghouse Air Brake Co.
Wright Power Saw & Tool Corp. Subsidiary of Thomas Industries

AIRLINE WATERTRAPS—see Pipeline Traps, Air, Steam & Water

AIR MOTORS

Acme Machinery Co.
Chicago Pneumatic Tool Co.
Detroit Hoist & Machine Co.
EIMCO CORP.
GARDNER-DENVER CO.
INGERSOLL-RAND CO.
Joy Mfg. Co.
Le Roi Div. Westinghouse Air Brake Co.
Thor Power Tool Co.

AIR PREHEATERS — see Heaters

AIR RECEIVERS — also see Tanks

Acme Machinery Co.
Atlas Copco Pacific, Inc.
Binks Mfg. Co.
Canadian Locomotive Co., Ltd.
Chicago Pneumatic Tool Co.
Curtis Manufacturing Co.
Davey Compressor Co.
GARDNER-DENVER CO.
Graver Tank & Mfg. Co., Inc.
INGERSOLL-RAND CO.
Joy Mfg. Co.
Westinghouse Air Brake Co.
Westinghouse Air Brake Co. Ind. Products Div.
Wilkerson Corp.

AIR VALVES—see Valves

AMALGAMATING PROCESS EQUIPMENT (SPECIAL)—does not include standard auxiliary equipment

DIESEL ENERGY CORP.
DENVER EQUIPMENT CO.
Blaw-Knox Co.
MINE & SMELTER SUPPLY CO., MFG. DIV.

AMMETERS & VOLTMETERS —see Meters, Electricity

ANEMOMETERS — see Meters, Fluid

ARCH PLATES — see Mine Supports

ARRESTERS, LIGHTNING

Carbone Corp.
Delta-Star Electric Div. H. K. Porter Company, Inc.
General Electric Co. Apparatus Sales Div.
Graybar Elc. Co., Inc.
Line Material Industries, McGraw-Edison Co.
Ohio Brass Co.
Union Switch & Signal Div., Westinghouse Air Brake Co.
Westinghouse Electric Corp.

ASSAYING & ANALYZING SERVICE—see Laboratory Service

ASSAYING & ANALYZING EQUIP.—see Chemical Lab. Equipment

B

BAG FILLING MACHINES

Bemis Bro. Bag Co.
Chase Bag Co.
Chattanooga Boiler & Tank Co.
Consolidated Packaging Machinery Corp.
Fulton Bag & Products Co.
Kraft Bag Corp.
Richardson Scale Co.
St. Regis Paper Co.

BAGS, PAPER, FABRIC & PLASTIC—also see: Blasting Bags; Filter Bags

Albany Felt Co.
Bemis Bro. Bag Co.
Chase Bag Co.
Daniels Co. Contractors, Inc.
Daniels, Inc., C. R.
Equitable Paper Bag Co., Inc.
Fulton Bag & Cotton Mills, Bag Div.
Hutchinson Bag Corp.
Kraft Bag Corp.
Miller Equipment Co., Inc.
National Filter Media Corp.
Pendleton Woolen Mills
St. Regis Paper Co.
Snyder & Son, Inc., M. L.
Stanley Co., Inc., William W.
Visking Co. Plastics Div.

BALL MILLS — see Mills, Ball

BALLS, GRINDING—see Mill Balls

BALLING EQUIPMENT—see Pelletizing Equipment

BARGES, FLOATING

Bethlehem Steel Co.
Kaiser Steel Corp., Fabricating Div.
Yuba Consolidated Industries, Inc.

BATTERIES, ELECTRIC—see Electrical Batteries

BEARINGS, BALL

Aetna Ball & Roller Bearing Co., Div. Parkersburg-Aetna Corp.
Ahlberg Bearing Co.
Corning Glass Works
Dodge Mfg. Corp.
Fafnir Bearing Co.
Federal Bearings Co., Inc.
Bearings Co. of America Div. Federal-Mogul-Bower Bearings, Inc.
Gwilliam Co.
Kaydon Engineering Corp.
LINK-BELT CO.
Marlin-Rockwell Corp.
New Departure Div. General Motors Corp.
Nice Ball Bearing Co.
Norma-Hoffman Bearings Corp.
SKF Industries, Inc.
Schatz Mfg. Co.
Split Ballbearing Corp.
Stephens-Adamson Mfg. Co.
Torrington Co. Bantam Bearings Div.

BEARINGS, NEEDLE

Kaydon Engineering Corp.
McGill Mfg. Co., Inc.
Orange Roller Bearing Co., Inc.
Torrington Co.
Torrington Co. Bantam Bearings Div.

BEARINGS, PLAIN, NON-METALLIC

American Brake Shoe Co.
Carbone Corp.
Gatke Corp.
Helwig Co.
McMillan's Sons, W. H.
Ohio Carbon Co.
Stackpole Carbon Co.
Synthane Corp.

BEARINGS, PLAIN, OIL-IMPREGNATED & SINTERED METAL

Bunting Brass & Bronze Co.
Carbone Corp.
Dodge Mfg. Corp.
Eaton Mfg. Co.
Federal-Mogul Service Div. Federal-Mogul-Bower Bearings, Inc.
Helwig Co.
Johnson Bronze Co.
Keystone Carbon Co.
Olds Alloy Co.
Pure Carbon Co.

BEARINGS, ROLLER

Aetna Ball & Roller Bearing Co. Div. Parkersburg-Aetna Corp.
Bower Roller Bearing Div. Federal-Mogul-Bower Bearings, Inc.
Chain Belt Co. Shafer Bearing Div.
Corning Glass Works
Dodge Mfg. Corp.
Federal-Mogul Service Div. Federal-Mogul-Bower Bearings, Inc.
General Motors Corp. Hyatt Bearings Div.
Gibraltar Equipment & Mfg. Co.
Gwilliam Co.
HEWITT-ROBINS, INC.
Kaydon Engineering Corp.
LINK-BELT CO.
Marlin-Rockwell Corp.
McGill Mfg. Co., Inc.
Norma-Hoffman Bearings Corp.
Orange Roller Bearing Co., Inc.
Rollway Bearing Co., Inc.
SKF Industries, Inc.
Timken Roller Bearing Co.
Torrington Co.
Torrington Co. Bantam Bearings Div.
Tyson Bearing Corp. Subsidiary of SKF Industries, Inc.

BEARINGS, SLEEVE

American Brake Shoe Co.
American Crucible Products Co.
Ampco Metal, Inc.
Bunting Brass & Bronze Co.
Carbone Corp.
Dodge Mfg. Corp.
Federal-Mogul Service Div. Federal-Mogul-Bower Bearings, Inc.
Flood City Brass & Elec. Co.
Gatke Corp.
Haynes Stellite Co. Div. Union Carbide Corp.
Imperial-Cantrell Mfg. Co.
Johnson Bronze Co.
LINK-BELT CO.
Ohio Carbon Co.
Olds Alloy Co.
STEARNS ROGER MFG. CO.
West Virginia Armature Co.
Williams & Son, E. A.

BEARINGS, THRUST

Aetna Ball & Roller Bearing Co. Div. Parkersburg-Aetna Corp.
American Brake Shoe Co.
American Crucible Products Co.
Bartlett & Snow Co., C.O.
Brass Foundry Co.
Bunting Brass & Bronze Co.
Carbone Corp.
Federal Bearings Co., Inc.
Bearings Co. of America Div. Federal-Mogul-Bower Bearings, Inc.
Gatke Corp.
Gibraltar Equipment & Mfg. Co.
Gwilliam Co.
Johnson Bronze Co.
Kaydon Engineering Corp.
LINK-BELT CO.
Marlin-Rockwell Corp.
New Departure Div. General Motors Corp.
Nice Ball Bearing Co.
Ohio Carbon Co.
Olds Alloy Co.
Orange Roller Bearing Co., Inc.
Rollway Bearing Co., Inc.
SKF Industries, Inc.
Saginaw Bearing Co.
Schatz Mfg. Co.
Timken Roller Bearing Co.
Torrington Co.
Torrington Co. Bantam Bearings Div.
Williams & Son, E. A.

BEARING METAL

Aluminum Co. of America
American Brake Shoe Co.
American Crucible Products Co.
AMERICAN SMELTING & REFINING CO. FEDERATED METALS DIV.
Ampco Metal, Inc.
Belmont Smelting & Refining Works, Inc.
Cadman Mfg. Co., A. W.
Carpenter Steel Co.
CRUCIBLE STEEL CO. OF AMERICA
Firth Sterling Inc.
Haynes Stellite Co. Div. Union Carbide Corp.
Imperial-Cantrell Mfg. Co.
Johnson Bronze Co.
LINK-BELT CO.
Mueller Brass Co.
National Lead Co.
Olds Alloy Co.

BEARING PILLOW BLOCKS, HANGERS & JOURNAL BOXES

Ahlberg Bearing Co.
Bartlett & Snow Co., C. O.
CARD IRON WORKS, C. S.
Chain Belt Co.
Chain Belt Co. Shafer Bearing Div.
Continental Gin Co. Industrial Div.
Dodge Mfg. Corp.
Fafnir Bearing Co.
Gatke Corp.
HEWITT-ROBINS, INC.
Jeffrey Mfg. Co.
Johnson Bronze Co.
Kanawha Mfg. Co.
LINK-BELT CO.
McNally Pittsburg Mfg. Corp.
New Departure Div. General Motors Corp.
Pickard Industries, Inc. Central Mine Supply Co., Div.
SKF Industries, Inc.
Stephens-Adamson Mfg. Co.
Webster Mfg., Inc.
Wood's Sons Co., T. B.

(BELTS, CONVEYOR — see Conveyor Belting)

BELTS, FLAT POWER TRANSMISSION

Acme Rubber Mfg. Co.
American Rubber Mfg. Co.
Boston Woven Hose & Rubber Co.
Carlyle Rubber Co.
Chicago Belting Div. Chicago-Allis Mfg. Corp.
Cincinnati Rubber Mfg. Co. Div. Thor Power Tool Co.
Daniels, Inc., C. R.
Dick Co., R & J.
Extremultus, Inc.
Goodall Rubber Co.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co. Industrial Products
Graton & Knight Co. Inc.
Hamilton Rubber Mfg. Corp.
HEWITT-ROBINS, INC.
Houghton & Co., E. F.
Johnson Belting Co.
Lovejoy Flexible Coupling Co.
Manheim Mfg. & Belting Co.
Missouri Belting Co.
Morse Chain Co.
New York Belting & Packing Co.
New York Rubber Corp.
Philadelphia Belting Co.
Quaker Rubber Div. H. K. Porter Company, Inc.
Raybestos-Manhattan, Inc. Manhattan Rubber Div.
Republic Rubber Div. Lee Rubber & Tire Corp.
Rhoads & Son, J. E.
Scandinavia Belting Co.
Thermoid Co. Industrial Div.
Thor Power Tool Co.
U. S. Rubber Co.
U. S. Rubber Co. Mechanical Goods Div.
Webb Belting & Supply Co.
Williams, I. B. & Sons

BELTS, "V"

Allis-Chalmers Mfg. Co. Industries Group
American Pulley Co.
Boston Woven Hose & Rubber Co.
Brammer Corp.
Browning Mfg. Co.
Carlyle Rubber Co.
Dick Co., R. & J.
Dodge Mfg. Corp.
Gates Rubber Co.
Goodall Rubber Co.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co. Industrial Products
Graton & Knight Co. Inc.
LINK-BELT CO.
Lovejoy Flexible Coupling Co.
Manheim Mfg. & Belting Co.
Missouri Belting Co.
New York Belting & Packing Co.
Quaker Rubber Div. H. K. Porter Company, Inc.
Raybestos-Manhattan, Inc. Manhattan Rubber Div.
Rhoads & Son, J. E.
Thermoid Co. Industrial Div.
U. S. Rubber Co.
U. S. Rubber Co. Mechanical Goods Div.
Webb Belting & Supply Co.
Wood's Sons Co., T. B.
Worthington Corp.

BELT DRESSING

Chicago Belting Div. Chicago-Allis Mfg. Corp.
Cling-Surface Co.
Dixon Crucible Co., Joseph
Goodrich Industrial Products Co., B. F.
Graton & Knight Co. Inc.
Houghton & Co., E. F.
Johnson Belting Co.
Missouri Belting Co.

Philadelphia Belting Co.
Rhoads & Son, J. E.
Scandinavia Belting Co.
Webb Belting & Supply Co.
Williams, I. B. & Sons

BINS & HOPPERS, BULK SOLIDS STORAGE—for liquids see Tanks

Acme Road Machinery Co., Inc.
Armco Drainage & Metal Products, Inc.
Arrow Tank Co.
Arrowhead Steel Buildings, Inc.
Baldwin-Lima-Hamilton Corp. Construction Equipment Div.
Bartlett & Snow Co., C. O.
Bethlehem Steel Co., Inc.
Bodinson Manufacturing Co., Inc.
Butler Bin Co.
Butler Mfg. Co.
Caldwell Co., W. E.
Canadian Locomotive Co., Ltd.
Chattanooga Boiler & Tank Co.
Chicago Bridge & Iron Co.
Columbian Steel Tank Co.
CONNELLSVILLE MFG. & MINE SUPPLY CO.
Daniels Co. Contractors, Inc.
DENVER EQUIPMENT CO.
Diamond Iron Works Div. Goodman Mfg. Co.
Engineered Equipment Inc.
Enterprise Wheel & Car Corp.
Erie Strayer Co.
Fuller Co.
Graver Tank & Mfg. Co., Inc.
Gruendler Crusher & Pulverizer Co.
HEWITT-ROBINS, INC.
Hirsch Bros. Machy. Co.
Holmes & Bros., Inc. Robert
Industrial Engrg. & Construction Co.
IOWA MFG. CO.
Irwin Foundry & Mine Car Co.
Johnson Co., C. S.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Kenyon Walker Machinery Co.
Kirk & Blum Mfg. Co.
Lakeside Bridge & Steel Co.
LINK-BELT CO.
Lippmann Engineering Works, Inc.
Mahon Co., R. C.
Marietta Concrete Corp.
Marsh Engineering Co., E. F.
MAYO TUNNEL & MINE EQUIPMENT
Meckum Engineering Inc.
Neff & Fry Co.
Ogden Iron Works
Ottumwa Box Car Loader Co.
Pioneer Engineering Div. Poor & Co. Inc.
Prins & Associates, K.
Richardson Scale Co.
Roberts & Schaefer Co., Subsidiary of Thompson Starrett Co., Inc.
Rogers Iron Works Co.
Santa Fe Tank Div. Fluor Products Co.
Specialty Engineering Co.
Standard Steel Corp.
STEARNS ROGER MFG. CO.
Stephens-Adamson Mfg. Co.
Telluride Iron Works Co.
TREADWELL CO., M. T.
Washington Machinery Co.
Webb Belting & Supply Co.
Webster Mfg., Inc.
Yuba Consolidated Industries, Inc., California Steel Products Div.

BIN & CHUTE GATES AND MECHANISMS — also see Feeders

ABCs Scale Div., McDowell Co., Inc.
Acme Road Machinery Co., Inc.
Bartlett & Snow Co., C. O.
Bodinson Manufacturing Co., Inc.
Butler Bin Co.
Butler Mfg. Co.
Canadian Locomotive Co., Ltd.
Chain Belt Co.
Columbus Conveyor Co.
DENVER EQUIPMENT CO.
Engineered Equipment Inc.
Erie Strayer Co.
Gruendler Crusher & Pulverizer Co.
Helmick Foundry-Machine Co.
HEWITT-ROBINS, INC.
Hirsch Bros. Machy. Co.
Holmes & Bros., Inc. Robert
Industrial Engrg. & Construction Co.
Jeffrey Mfg. Co.
Johnson Co., C. S.
LINK-BELT CO.
Lippmann Engineering Works, Inc.
Marsh Engineering Co., E. F.
MAYO TUNNEL & MINE EQUIPMENT
McNally Pittsburg Mfg. Corp.
Meckum Engineering Inc.
NATIONAL IRON CO.
Ogden Iron Works
Pioneer Engineering Div. Poor & Co. Inc.
Prins & Associates, K.
Richardson Scale Co.
Roberts & Schaefer Co., Subsidiary of Thompson Starrett Co., Inc.
Rogers Iron Works Co.
Smith Engineering Works
Specialty Engineering Co.
Standard Steel Corp.
STEARNS ROGER MFG. CO.
Stephens-Adamson Mfg. Co.
Telluride Iron Works Co.
Washington Machinery Co.
Webb Belting & Supply Co.
Webster Mfg., Inc.

BINS & TANK-LEVEL INDICATORS—also see Meters & Gages

BIN-DICATOR CO.
Builders-Providence Div. B-I-F Industries
Butler Bin Co.
Conwair, Inc.
Engineered Equipment Inc.
Erie Strayer Co.
Falcon Alarm Co., Inc.
Femco, Inc.
Fuller Co.
General American Transportation Corp.
General Equipment & Mfg. Co.
HEWITT-ROBINS, INC.
Jeffrey Mfg. Co.
Nuclear Research Corp.
Revere Corp. of America
Santa Fe Tank Div. Fluor Products Co.
Stephens-Adamson Mfg. Co.
Syntron Co.
Texas Instruments, Inc. Industrial Instrumentation Div.
Vapor Recovery Systems Co.

BITS—see Drill (Rock) Bits

BLAST CLEANING EQUIPMENT

Norton Co.
Pangborn Corp.
Pettinos, Inc., George F.
Sly Mfg. Co., W. W.
U. S. Rubber Co. Mechanical Goods Div.
Wheelabrator Corp.

BLASTING COMPOUNDS (I.E. EXPLOSIVES)

American Cyanamid Co., Explosives & Mining Chemicals Dept.
Apache Powder Co.
Atlas Powder Co.
Austin Powder Co.
Canadian Industries Ltd.
Columbia Powder Co.
Commercial Solvent Corp.
DuPont de Nemours & Co., Inc., E. I. Explosives Dept.
DuPont de Nemours & Co., Inc., E. I. Egyptian Powder Co.
Equitable Powder Mfg. Co.
HERCULES POWDER CO.
King Powder Co.
National Powder Co.
Olin-Mathieson Chemical Corp. Explosives Div.
Pacific Powder Co.
SPENCER CHEMICAL CO.
Trojan Powder Co.
U. S. Powder Co.
West Coast Powder Co.

BLASTING DETONATORS (I.E. CAPS)

AMERICAN CYANAMID CO., EXPLOSIVES & MINING CHEMICALS DEPT.
Atlas Powder Co.
Canadian Industries Ltd.
DuPont de Nemours & Co., Inc., E. I.
DuPont de Nemours & Co., Inc., E. I. Explosives Dept.
Equitable Powder Mfg. Co.
HERCULES POWDER CO.
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Div.
Trojan Powder Co.

BLASTING FUSES, SAFETY, DETONATING, ET AL

AMERICAN CYANAMID CO., EXPLOSIVES & MINING CHEMICALS DEPT.
Atlas Powder Co.
Canadian Industries Ltd.
Coast Mfg. & Supply Co.
DuPont de Nemours & Co., Inc., E. I. Explosives Dept.
DuPont de Nemours & Co., Inc., E. I.
ENSIGN-BICKFORD CO.
Equitable Powder Mfg. Co.
HERCULES POWDER CO.
National Fuse & Powder Co.
National Powder Co.
Olin-Mathieson Chemical Corp. Explosives Div.
Trojan Powder Co.

BLASTING BAGS, POWDER & TAMPING

AMERICAN CYANAMID CO., EXPLOSIVES & MINING CHEMICALS DEPT.
Apache Powder Co.
Atlas Powder Co.
Bemis Bros. Bag Co.
Canadian Industries Ltd.
Chase Bag Co.
DuPont de Nemours & Co., Inc., E. I. Explosives Dept.
DuPont de Nemours & Co., Inc., E. I.
Fulton Bag & Products Co.
HAMMOND CO., J. V.
National Mine Service Co.
National Powder Co.
Olin-Mathieson Chemical Corp. Explosives Div.
Pickard Industries, Inc. Central Mines Supply Co., Div.
Trojan Powder Co.
Visking Co. Plastics Div.

BLASTING EQUIPMENT & ACCESSORIES, MISCELLANEOUS

Abbott, Charles & Associates
AMERICAN CYANAMID CO., EXPLOSIVES & MINING CHEMICALS DEPT.
Atlas Powder Co.
Canadian Industries Ltd.
DuPont de Nemours & Co., Inc., E. I.
DuPont de Nemours & Co., Inc. E. I. Explosives Dept.
ENSIGN-BICKFORD CO.
Equitable Powder Mfg. Co.
Femco, Inc.
Gray Instrument Co.
HAMMOND CO., J. V.
HERCULES POWDER CO.
Johnson Loading Supplies, G. R.
National Fuse & Powder Co.
National Powder Co.
Olin-Mathieson Chemical Corp. Explosives Div.
Southwestern Industrial Electronics Co.
SPRENGNETHER INSTRUMENT CO., INC. W. F.
Texas Instruments. Inc. Industrial Instrumentation Div.
Trojan Powder Co.
VICTOR EQUIPMENT CO. ALLOY ROD & METAL DIV.

BLASTING MACHINES & SWITCHES, ELECTRIC

AMERICAN CYANAMID CO., EXPLOSIVES & MINING CHEMICALS DEPT.
Atlas Powder Co.

BLASTING (& CONNECTING) WIRE

AMERICAN CYANAMID CO., EXPLOSIVES & MINING CHEMICALS DEPT.
Atlas Powder Co.
Canadian Industries Ltd.
DuPont de Nemours & Co., Inc., E. I
DuPont de Nemours & Co., Inc., E. I. Explosives Dept.
HERCULES POWDER CO.
National Powder Co.
Olin-Mathieson Chemical Corp. Explosives Div.
Pickard Industries, Inc. Central Mine Supply Co. Div.
Roebling's Sons Corp., John A. Subsidiary of Colorado Fuel & Iron Co.
Rome Cable Corp.
Trojan Powder Co.
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.

(BLENDERS—see Agitators)

BLOCKS, PULLEYS & SHEAVES — also see Sheaves, Mine Hoist

Alloy Steel & Metals Co.
American Hoist & Derrick Co.
American Pulley Co.
Bartlett & Snow Co., C. O.
Bonded Scale & Machine Co.
CARD IRON WORKS, C. S.
Continental Gin Co. Industrial Div.
Dick Co., R. & J.
Dodge Mfg. Corp.
Electric Steel Foundry Co.
Farrel-Cheek Steel Co.
Frog, Switch & Mfg. Co.
Griphoist, Inc.
HEWITT-ROBINS, INC.
Holmes & Bros. Inc. Robert
Joy Mfg. Co.
Keeney Co., Paul E.
Lake Shore, Inc. Lake Shore Engineering Div.
Lebus Mfg. Co. Subsidiary of American Hoist & Derrick Co.
Lovejoy Flexible Coupling Co.
Madesco Tackle Block Co.
McKiernan-Terry Corp.
McMillan's Sons, W. H.
McNally Pittsburg Mfg. Corp.
Paulsen-Webber Cordage Corp.
Princeton Griphoist, Inc.
Sanford-Day Iron Works, Inc.
SAUERMAN BROS., INC.
Skookum Co., Inc.
Telluride Iron Works Co.
Tool Steel Gear & Pinion Co.
U. S. Rubber Co. Mechanical Goods Div.
Washington Machinery Co.
Western Block Co.
Wood's Sons Co., T. B.

(BLOWERS—see: Fans; Concrete Sprayers; Refractory Placers)

BLUE, PHOTO & WHITE PRINT MACHINES

Bruning Co., Inc. Charles
Ozalid Div. General Aniline & Film Corp.
Paragon-Revolute Corp.
Pease Co., C. F.
Peck & Harvey Mfg. Corp.
Peerless Photo Products, Inc.
Post Co., Frederick
Remington Rand Div. Sperry Rand Corp.
Suverkrop Instruments

BOILERS & HEATERS, LIQUID—does not include: Heaters, Space; Retorts

Alco Products, Inc.
Ames Iron Works, Inc.
BABCOCK & WILCOX CO.
Clayton Mfg. Co.
Cochrane Corp.
Combustion Engineering Inc.
Condenser Service & Engineering Co.
Foster Wheeler Corp.
Industrial Brownhoist Corp.
Keeler Co., E.
Leffel & Co., James
Ogden Iron Works
Process Engineering, Inc.
Prox Co., Inc. Frank
Quick Charge, Inc.
Ross Heat Exchanger Div. American Standard
Southwestern Engineering Co.
Springfield Boiler Co.
Yuba Consolidated Industries, Inc., Adsco Div.

BOLTS—see: Fasteners; Rock Bolts

BOOMS, LOADING — see: Cranes; Conveyors

BOOMS & TOWERS, EXTENSIBLE & MOTILE, MOBILE & STATIONARY—does not include: Drill (Rock) Booms; Drill (Rock) Jumbos; Booms, Loading

Ballymore Co.
INGERSOLL-RAND CO.
LINK-BELT CO.
Mobile Aerial Towers, Inc.
Rogers Iron Works Co.

BRAKES, DYNAMIC — also see Brakes, Magnetic

Westinghouse Electric Corp.

BRAKES, FRICTION DISK & BLOCK

American Brake Shoe Co.
American Chain & Cable Co., Inc.

Automotive & Aircraft Div.
Asbestos Mfg. Co.
Fawick Airflex Co., Inc.
Gatke Corp.
GOODRICH AVIATION PRODUCTS, B. F. DIV., GOODRICH CO., B. F.
Goodyear Tire & Rubber Co.
Johns-Manville
Pickard Industries, Inc. Central Mine Supply Co., Div.
Rockwell Spring & Axle Co. Timken-Detroit Axle Div.
Wagner Electric Corp.
Wellman Co., S. K.

BRAKES, MAGNETIC

American Rectifier Corp. Selenibrake Div.
Clark Controller Co.
Cutler-Hammer, Inc.
Dings Magnetic Separator Co.
Eaton Mfg. Co.
Electric Controller & Mfg. Co. Div. Square D. Co.
General Electric Co. Apparatus Sales Div.
Miehle Printing Press & Mfg. Co. Star-Kimble Motor Div.
Trombetta Solenoid Corp.
Westinghouse Electric Corp.

BRATTICE CLOTH

AMERICAN BRATTICE CLOTH CORP.
Daniels, Inc., C. R.
Flocker & Co., John
Fulton Bag & Products Co.
Goodrich Industrial Products Co., B. F.
Johnston-Morehouse-Dickey Co.
Pickard Industries, Inc. Central Mine Supply Co., Div.
White Lamb Finaly, Inc.

BREAKERS, CIRCUIT — see Electric Switchgear

BRIQUETTING EQUIPMENT —does not include: Nodulizing, Pelletizing-Balling or Sintering Equipment

Huzemag USA Inc.

BRUSHES, ELECTRICAL — see Electrical Brushes

BUCKETS, BUCKETLINE DREDGE

American Brake Shoe Co. American Manganese Steel Div.
American Brake Shoe Co.
Electric Steel Foundry Co.
Frog, Switch & Mfg. Co.
Sorel Steel Foundries, Ltd.
Washington Iron Works
Yaun Mfg. Co., Inc.
Yuba Consolidated Industries, Inc., Yuba Mining Div.

BUCKETS, CLAMSHELL & GRAB

AUSTIN-WESTERN CONSTRUCTION EQUIPMENT DIV. BALDWIN-LIMA-HAMILTON CORP.
Blaw-Knox Co.
Electric Steel Foundry Co.
Erie Strayer Co.
Frog, Switch & Mfg. Co.
Hales Co., W. M.
HARNISCHFEGER CORP.
Hayward Co.
Industrial Brownhoist Corp.
Johnson Co., C. S.
McKiernan-Terry Corp.
Orton Crane & Shovel Co.
Owen Bucket Co.
Pettibone Mulliken Corp.
Salem-Brosius, Inc.
Schield Bantam Co.
Williams Bucket Div., Wellman Engineering Co.
Yaun Mfg. Co., Inc.
Yuba Consolidated Industries, Inc., Yuba Mining Div.

BUCKETS, CONVEYOR & ELEVATOR—does not include Buckets, Tramway & Trolley

Acme Road Machinery Co., Inc.
American Brake Shoe Co. American Manganese Steel Div.
Bartlett & Snow Co., C. O.
Bodinson Manufacturing Co., Inc.
Bonded Scale & Machine Co.
Butler Bin Co.
Butler Mfg. Co.
Chain Belt Co.
Christian Engineers, J. D.
Columbus Conveyor Co.
Continental Gin Co. Industrial Div.
Erie Strayer Co.
Farrell-Cheek Steel Co.
Gibraltar Equipment & Mfg. Co.
Goodrich Industrial Products Co., B. F.
Gruendler Crusher & Pulverizer Co.
Hack Engineering Co.
Helmick Foundry-Machine Co.
Hendrick Mfg. Co.
HEWITT-ROBINS, INC.
Jeffrey Mfg. Co.
Johnson Co., C. S.
Kanawha Mfg. Co.
Kirk & Blum Mfg. Co.
Kremser & Sons, Inc. Frank A.
Laubenstein Mfg. Co.
LINK-BELT CO.
Lippmann Engineering Works, Inc.
Marsh Engineering Co., E. F.
McNally Pittsburg Mfg. Corp.
NATIONAL MALLEABLE & STEEL CASTINGS CO.
Ogden Iron Works
Pettibone Mulliken Corp.
Pioneer Engineering Div. Poor & Co. Inc.
Roberts & Schaefer Co., Subsidiary of Thompson Starrett Co., Inc.
Rogers Iron Works Co.
Savage Co., W. J.
Specialty Engineering Co.
Standard Metal Mfg. Co.
Stephens-Adamson Mfg. Co.
Union Chain & Mfg. Co.
Universal Dredge Mfg. Co.
Universal Road Machinery Co.
Washington Machinery Co.
Webster Mfg., Inc.

BUCKETS, DIPPER SHOVEL

American Brake Shoe Co. American Manganese Steel Div.
American Brake Shoe Co.
Bucyrus-Erie Co.
Electric Steel Foundry Co.
Frog, Switch & Mfg. Co.
Hendrix Mfg. Co.
Landis Steel Co.
Marion Power Shovel Co.
Orton Crane & Shovel Co.
Pettibone Mulliken Corp.
Schield Bantam Co.
Sorel Steel Foundries, Ltd.

BUCKETS, DRAGLINE CRANE

Bucyrus-Erie Co.
Electric Steel Foundry Co.
Frog, Switch & Mfg. Co.
Hales Co., W. M.
HARNISCHFEGER CORP.
Marion Power Shovel Co.
Orton Crane & Shovel Co.
Page Engineering Co.
Schield Bantam Co.
Sorel Steel Foundries, Ltd.
Williams Bucket Div., Wellman Engineering Co.
Yaun Mfg. Co., Inc.

BUCKETS, DRAGLINE SCRAPER-SLUSHER

Alloy Steel & Metals Co.
EIMCO CORP.
Electric Steel Foundry Co.
Frog, Switch & Mfg. Co.
Landis Steel Co.
Orton Crane & Shovel Co.
Pettibone Mulliken Corp.
SAUERMAN BROS. INC.
Twin City Iron Works
Vulcan Iron Works Co., (Denver)
Washington Machinery Co.
Yaun Mfg. Co., Inc.

BUCKETS, HOISTING & SINKING — does not include Skips & Cages

DENVER EQUIPMENT CO.
Hirsch Bros. Machy. Co.
Holmes & Bros., Inc. Robert
MAYO TUNNEL & MINE EQUIPMENT
Pollock Co., William B.
Vulcan Iron Works Co., (Denver)
Yaun Mfg. Co., Inc.

BUCKETS, TRAMWAY & TROLLEY

Richards-Wilcox Mfg. Co.

BUCKET TEETH & WEAR-REPLACEMENT PARTS

American Brake Shoe Co. American Manganese Steel Div.
American Brake Shoe Co.
Bucyrus-Erie Co.
Electric Steel Foundry Co.
Erie Strayer Co.
Farrell-Cheek Steel Co.
Frog, Switch & Mfg. Co.
H. & L. Tooth Co.
Hayward Co.
Industrial Brownhoist Corp.
Industrial Overlay Metals, Inc.
Kensington Steel Div., Poor & Co.
Ladish Co.
Manganese Steel Forge Co.
Marion Power Shovel Co.
NATIONAL MALLEABLE & STEEL CASTINGS CO.
Owen Bucket Co.
SAUERMAN BROS., INC.
Sorel Steel Foundries, Ltd.
Stulz-Sickles Co.
Wellman Engineering Co. McDowell Enterprise.

BUILDINGS, PREFAB

Armco Drainage & Metal Products, Inc.
Arrowhead Steel Buildings, Inc.
Black, Sivalls & Bryson, Inc.
Butler Manufacturing Co.
Dresser-Ideco Co.
Inland Steel Products Co.
Republic Steel Corp.
Republic Steel Corp. Truscon Steel Div.
Steel-Bilt Construction Co.
Steelcraft Mfg. Co.

BULLDOZERS & ANGLE DOZER BLADES—see Tractor Attachments

BURNERS, OIL, GAS & COAL (for Heaters, Furnaces, Kilns, etc.)

Hauck Mfg. Co.
BABCOCK & WILCOX CO.

BURNERS, HAND TORCH & MOBILE (for Thawing, Weed Burning, etc.)—also see Car Thawers; does not include Welding & Cutting Equipment

Hauck Mfg. Co.

C

CABLE — see: Electrical Cable; Wire Rope

CABLEWAYS — see Aerial Tramways

CAGES, MINE HOIST — see Skips & Cages

CALCULATORS — see: Computing Machines; Drafting Equip.; Meters; Office Machines

CAP LAMPS, CARBIDE

Geophysical Instrument & Supply Co.
Justrite Mfg. Co.

CAP LAMPS, ELECTRIC

Justrite Mfg. Co.
MINE SAFETY APPLIANCES CO.
National Carbon Co. Union Carbide Corp.
National Mine Service Co.
Nife, Inc.

CAP LAMP CARBIDE

Air Reduction Sales Co., Div. Air Reduction Co., Inc.
Geophysical Instrument & Supply Co.
Linde Co. Union Carbide Corp.

CARBIDES, TUNGSTEN & OTHER HARD METALS (SINTERED, CEMENTED, ETC.)

Adamas Carbide Co.
Air Reduction Sales Co., Div. Air Reduction Co., Inc.
Allegheny Ludlum Steel Corp.
Carbone Corp.
Firth Sterling Inc.
Hoyland Steel Co., Inc.
Industrial Overlay Metals, Inc.
KENNAMETAL INC. MINING TOOL DIV.
Metal Carbides Corp.
Metallurgical Products Dept. General Electric Co.
Newcomer Products, Inc.
Sight Feed Generator Co.
VASCOLOY-RAMET CORP.

CARS, COMMERCIAL RAILROAD

Ateco Div. Greenville Steel Car Co.
Dominion Steel & Coal Corp., Ltd.
Easton Car & Construction Co.
Frank, M. K.
Gregg Co., Ltd.

CARS, MINE R.R.—also see specific types below

American Car & Foundry Div. ACF Industries, Inc.
Bethehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
CARD IRON WORKS, C. S.
Coeur d'Alene Hardware & Foundry Co.
CONNELLSVILLE MFG. & MINE SUPPLY CO.
DENVER EQUIPMENT CO.
Differential Steel Car Co.
Dominion Steel & Coal Corp., Ltd.
Easton Car & Construction Co.
Enterprise Wheel & Car Corp.
Frank, M. K.
General American Transportation Corp.
Getman Brothers
Gibraltar Equipment & Mfg. Co.
Gregg Co. Ltd.
Helmick Foundry-Machine Co.
Hirsch Bros. Machy. Co.
Hockensmith Corp.
Irwin Foundry & Mine Car Co.
Kaiser Steel Corp., Fabricating Div.
Lake Shore, Inc. Lake Shore Engineering Div.
MAYO TUNNEL & MINE EQUIPMENT
MAGOR CAR CORP.
Moran Engineering Co.
Sanford-Day Iron Works, Inc.
Telluride Iron Works Co.
Watt Car & Wheel Co.

CARS, MINE R.R. AUTOMATIC DUMP

American Car & Foundry Div. ACF Industries, Inc.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co.
CARD IRON WORKS, C. S.
Differential Steel Car Co.
Easton Car & Construction Co.
Enterprise Wheel & Car Corp.
Frank, M. K.
Gregg Co., Ltd.
Hirsch Bros. Machy. Co.
Irwin Foundry & Mine Car Co.
Lake Shore, Inc. Lake Shore Engineering Div.
MAGOR CAR CORP.
Moran Engineering Co.
NATIONAL IRON CO.
Sanford-Day Iron Works, Inc.
Watt Car & Wheel Co.

CARS, MINE R.R., FIRE—also see Fire Fighting Equipment

Irwin Foundry & Mine Car Co.
MINE SAFETY APPLIANCES CO.
Watt Car & Wheel Co.

CARS, MINE R.R., HAND DUMP

American Car & Foundry Div. ACF Industries, Inc.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
CARD IRON WORKS, C. S.
DENVER EQUIPMENT CO.
Differential Steel Car Co.
Easton Car & Construction Co.

Enterprise Wheel & Car Corp.
Frank, M. K.
Gregg Co., Ltd.
Helmick Foundry-Machine Co.
Hirsch Bros. Machy. Co.
Hockensmith Corp.
Irwin Foundry & Mine Car Co.
Lake Shore, Inc. Lake Shore Engineering Div.
MAYO TUNNEL & MINE EQUIPMENT
Moran Engineering Co.
Ogden Iron Works
Sanford-Day Iron Works, Inc.
Watt Car & Wheel Co.

CARS, MINE & INDUSTRIAL R.R., MAN & SPECIAL TYPES

American Car & Foundry Div. ACF Industries, Inc.
Atlas Car & Mfg. Co.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
CARD IRON WORKS, C. S.
Differential Steel Car Co.
Easton Car & Construction Co.
Enterprise Wheel & Car Corp.
Frank, M. K.
Getman Bothers
Gibraltar Equipment & Mfg. Co.
Gregg Co., Ltd.
Helmick Foundry-Machine Co.
Hirsch Bros. Machy. Co.
Hockensmith Corp.
Holmes & Bros., Inc. Robert
Irwin Foundry & Mine Car Co.
Kersey Mfg. Co., Inc.
Lake Shore, Inc. Lake Shore Engineering Div.
Lee-Norse Co.
Moran Engineering Co.
Ogden Iron Works
Sanford-Day Iron Works, Inc.
Watt Car & Wheel Co.
Yuba Consolidated Industries, Inc., Yuba Mfg. Div.

CARS, SHUTTLE — see Trucks

CAR ACCESSORIES, MINE & COMMERCIAL R.R. — see below; also see: Track . . .; Rail . . .

CAR (R.R.) BODIES

American Car & Foundry Div. ACF Industries, Inc.
Gregg Co., Ltd.

CAR CAGERS & SPOTTERS—does not include Car Movers

CARD IRON WORKS, C. S.
CONNELLSVILLE MFG. & MINE SUPPLY CO.
Flood City Brass & Elec. Co.
Hirsch Bros. Machy. Co.
Holmes & Bros., Inc. Robert
Maschinenfabrik Rudolf Hausherr & Soehne, GmbH, c/o B. J. Nykerk Corp.
Nolan Co.
Roberts & Schaefer Co.. Subsidiary of Thompson Starrett Co., Inc.
Sanford-Day Iron Works, Inc.
Stamler Corp., W. R.

CAR (R.R.) COUPLERS & DRAFT GEAR

CARD IRON WORKS, C. S.
Differential Steel Car Co.
Duquesne Mine Supply Co.
Enterprise Wheel & Car Corp.
Frank, M. K.
Gregg Co., Ltd.
Irwin Foundry & Mine Car Co.
MAYO TUNNEL & MINE EQUIPMENT
Moran Engineering Co.
NATIONAL MALLEABLE & STEEL CASTINGS CO.
Ohio Brass Co.
Sanford-Day Iron Works, Inc.
Utility Mine Equipment Co.

CAR (R.R.) DERAILERS & RERAILERS & CHOCKS—does not include switchtype derailers; see Rail Switches

Aldon Co.
Duquesne Mine Supply Co.
Foster Co., L. B.
Gibraltar Equipment & Mfg. Co.
Frank, M. K.
Miners' Hardware Supply Co.
Nolan Co.
Pettibone Mulliken Corp.
Sanford-Day Iron Works, Inc.

CAR (& TRUCK) DUMPING DEVICES

CARD IRON WORKS, C. S.
CONNELLSVILLE MFG. & MINE SUPPLY CO.
Differential Steel Car Co.
Easton Car & Construction Co.
Frank, M. K.
Galion Allsteel Body Co.
Heil Co.
HERCULES STEEL PRODUCTS CO.
Heyl & Patterson, Inc.
Holmes & Bros., Inc. Robert
Industrial Brownhoist Corp.
Kanawha Mfg. Co.
Lake Shore, Inc. Lake Shore Engineering
LINK-BELT CO.
McKiernan-Terry Corp.
McNally Pittsburg Mfg. Corp.
Moran Engineering Co.
Nolan Co.
Ottumwa Box Car Loader Co.
Roberts & Schaefer Co., Subsidiary of Thompson Starrett Co., Inc.
Rogers Iron Works Co.
Truck Engineering Corp.
Wellman Engineering Co. McDowell Enterprise

CAR (R.R.) MOVERS, HAND

Advance Car Mover Co., Inc.
Aldon Co.
Atlas Car & Mfg. Co.
Christian Engineers, J. D.
Foster Co., L. B.
Frank, M. K.
Gibraltar Equipment & Mfg. Co.
LINK-BELT CO.
McNally Pittsburg Mfg. Corp.

CAR (R.R.) MOVERS, SPECIAL TRACTOR TYPE

Atlas Car & Mfg. Co.
Easton Car & Construction Co.
Frank, M. K.
Hough Co., Frank G.
LE TOURNEAU-WESTINGHOUSE CO.
Westinghouse Air Brake Co.
Whiting Corp.

CAR (R.R.) MOVERS, WINCH TYPE

Bartlett & Snow Co., C. O.
Bodinson Manufacturing Co., Inc.
Christian Engineers, J. D.
Clyde Iron Works, Inc.
Electro Lift, Inc.
Foster Co., L. B.
Frank, M. K.
HEWITT-ROBINS, INC.
Heyl & Patterson, Inc.
Holmes & Bros., Inc. Robert
Jeffrey Mfg. Co.
Joy Mfg. Co.
Lidgerwood Industries, Inc.
LINK-BELT CO.
McKiernan-Terry Corp.
McNally Pittsburg Mfg. Corp.
O.K. Machinery Div. John C. Motter Printing Press Co.
Sanford-Day Iron Works, Inc.
Silent Hoist & Crane Corp.
Stephens-Adamson Mfg. Co.
Stimmel Winch Co., Inc.
Superior-Lidgerwood-Mundy Corp.
Vulcan Iron Works Co., (Denver)
Washington Machinery Co.
Webster Mfg., Inc.

CAR (R.R.) RETARDERS

CONNELLSVILLE MFG. & MINE SUPPLY CO.
Frank, M. K.
Heyl & Patterson, Inc.
Holmes & Bros., Inc. Robert
LINK-BELT CO.
McNally Pittsburg Mfg. Corp.
Miners' Hardware Supply Co.
Nolan Co.
Sanford-Day Iron Works, Inc.
Union Switch & Signal Div., Westinghouse Air Brake Co.
Webster Mfg., Inc.

CAR SHAKERS

Allis-Chalmers Mfg. Co. Industries Group
Frank, M. K.
HEWITT-ROBINS, INC.
Heyl & Patterson, Inc.
LINK-BELT CO.
Martin Engineering Co.
Webster Mfg., Inc.

CAR (R.R.) TRANSFERS, PASSERS, ETC.

AMERICAN MINE DOOR CO.
Atlas Car & Mfg. Co.
CARD IRON WORKS, C. S.
Easton Car & Construction Co.
Frank, M. K.
MAYO TUNNEL & MINE EQUIPMENT
Telluride Iron Works Co.

CAR (R.R.) TRUCKS—also see Car Wheels

NATIONAL MALLEABLE & STEEL CASTINGS CO.
Sanford-Day Iron Works, Inc.

CAR (R.R.) TURNTABLES

Atlas Car & Mfg. Co.
Bethlehem Pacific Coast Steel Corp.
CARD IRON WORKS, C. S.
Easton Car & Construction Co.
Foster Co., L. B.
Frank, M. K.
HARDINGE CO., INC.
Irwin Foundry & Mine Car Co.
MAYO TUNNEL & MINE EQUIPMENT
Whiting Corp.

CAR (& TRUCK) THAWERS

Hauck Mfg. Co.
Vulcan Electric Co.

CAR (& LOCOMOTIVE) WHEELS & AXLES

Alco Products, Inc.
American Brake Shoe Co. American Manganese Steel Div.
American Car & Foundry Div. ACF Industries, Inc.
Atlas Car & Mfg. Co.
Baldwin-Lima-Hamilton Corp. Standard Steel Works Div.
Bethlehem Steel Co.
Bethlehem Pacific Coast Steel Corp.
Canadian Locomotive Co., Ltd.
CARD IRON WORKS, C. S.
Differential Steel Car Co.
Dominion Steel & Coal Corp., Ltd.
Easton Car & Construction Co.
Enterprise Wheel & Car Corp.
Farrell-Cheek Steel Co.
Frank, M. K.
Hockensmith Corp.
Ironton Engine Co.
Irwin Foundry & Mine Car Co.
Kersey Mfg. Co., Inc.
Moran Engineering Co.
NATIONAL MALLEABLE & STEEL CASTINGS CO.
Rockwell Spring & Axle Co. Timken-Detroit Axle Div.
Rogers Iron Works Co.
Sanford-Day Iron Works, Inc.
Sterling Steel Casting Co.
Tennessee Coal & Iron Div. U. S. Steel Corp.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
Watt Car & Wheel Co.

CAR WHEEL & GEAR PULLERS

Armstrong, Bray & Co.
Crane Puller Co.
Frank, M. K.
Owatonna Tool Co.

CASTING WHEELS, SMELTER

TREADWELL CO., M. H.
TRAYLOR ENGINEERING & MFG. CO.

CASTINGS, IRON (GRAY, MALLEABLE, ETC.)

American Brake Shoe Co.
American Car & Foundry Div. ACF Industries, Inc.
American Chain & Cable Co. Inc., Acco Malleable Casting Div.
Auto-Lite Battery Corp.
Badger Malleable & Mfg. Co.
Belle City Malleable Iron Co. Racine Steel Castings Co.
Bethlehem Foundry & Machine Co.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Cadillac Malleable Iron Co.
Calumet Div. Calumet & Hecla, Inc.
CARD IRON WORKS, C. S.
Chain Belt Co.
Continental Gin Co. Industrial Div.
Cooper-Bessemer Corp.
Davis Foundry & Machine Works
Eagle Iron Works
Eaton Mfg. Co.
Enterprise Wheel & Car Corp.
Farrel-Birmingham Co., Inc.
Gibraltar Equipment & Mfg. Co.
Goyne Pump Co.
HARDINGE CO., INC.
Helmick Foundry-Machine Co.
Hockensmith Corp.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Lake Shore, Inc. Lake Shore Engineering Div.
LINK-BELT CO.
McLanahan & Stone Corp.
Meeker Foundry Co.
NATIONAL IRON CO.
NATIONAL MALLEABLE & STEEL CASTINGS CO.
NORDBERG MFG. CO.
Ogden Iron Works
Prox Co., Inc., Frank
Sheppard Co., Inc., R. H.
Square D Co.
Rogers Iron Works Co.
St. Louis Malleable Casting Co.
Sanford-Day Iron Works, Inc.
Shrivers, & Co., T.
STEARNS ROGER MFG. CO.
Swett Iron Works, A. L.
Telluride Iron Works Co.
TREADWELL CO., M. H.
Union Chain & Mfg. Co.
U. S. Pipe & Foundry Co.
Washington Iron Works
Webster Mfg., Inc.
Wood's Sons Co., T. B.

CASTINGS, FERROUS ALLOYS

American Car & Foundry Div. ACF Industries Inc.
Allegheny Ludlum Steel Corp.
American Brake Shoe Co.
American Brake Shoe Co. American Manganese Steel Div.
American Chain & Cable Co, Inc. Acco Steel Casting Div.
Atlas Steel Casting Co.
Auto-Lite Battery Corp.
BABCOCK & WILCOX CO.
Belle City Malleable Iron Co. Racine Steel Castings Co.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Calumet Div. Calumet & Hecla, Inc.
CRUCIBLE STEEL CO. OF AMERICA
Duriron Co., Inc.
Eagle Iron Works
Electric Steel Foundry Co.
Empire Steel Castings, Inc.
Enterprise Wheel & Car Corp.
Farrell-Cheek Steel Co.
Gibraltar Equipment & Mfg. Co.
Goyne Pump Co.
Industrial Overlay Metals, Inc.
Kanawha Mfg. Co.
Kensington Steel Co.
KW-DART TRUCK CO.
Lebanon Steel Foundry
Los Angeles Steel Casting Co.
McNally Pittsburg Mfg. Corp.
NATIONAL MALLEABLE & STEEL CASTINGS CO.
NATIONAL SUPPLY CO.
Sawyer Belt Hook & Wedge Co., Inc.
STEARNS ROGER MFG. CO.
Taylor-Wharton Co. Div. Harsco Corp.
Thomas Foundries, Inc.
TREADWELL CO., M. H.

CASTINGS, NONFERROUS

Alloy Steel Casting Co.
Aluminum Co. of America
American Brake Shoe Co.
American Crucible Products Co.
Ampco Metal, Inc.
Belmont Smelting & Refining Works
Beryllium Corp.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Brass Foundry Co.
Bridgeport Brass Co.
Cadman Mfg. Co., A. W.
CRUCIBLE STEEL CO. OF AMERICA
Enterprise Wheel & Car Corp.
Flood City Brass & Elec. Co.
Gibraltar Equipment & Mfg. Co.
Goyne Pump Co.
Haynes Stellite Co. Div. Union Carbide

Corp.
HOFFMAN BROS. DRILLING CO.
International Nickel Co.
Leavitt Machine Co.
Lumen Bearing Co.
Mueller Brass Co.
National Lead Co.
Ogden Iron Works
Olds Alloy Co.
Permold Co.
Sawyer Belt Hook & Wedge Co., Inc.
Shriver & Co., T.
Star Brass Works
Stoody Co.
Titan Metal Mfg. Co.
TREADWELL CO., M. H.
West Virginia Armature Co.
Williams & Son, E. A.

CASTINGS, STEEL

Acme Machinery Co.
Alloy Steel & Metals Co.
American Brake Shoe Co.
American Brake Shoe Co. American Manganese Steel Div.
American Chain & Cable Co., Inc.
American Steel Foundries
Atlas Steel Casting Co.
BABCOCK & WILCOX CO.
Baldwin-Limt-Hamilton Corp. Standard Steel Works Div.
Belle City Malleable Iron Co. Racine Steel Castings Co.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Birdsboro Steel Foundry & Machine Co.
CARD IRON WORKS, C. S.
CRUCIBLE STEEL CO. OF AMERICA
Duriron Co., Inc.
Electric Steel Foundry Co.
Empire Steel Castings, Inc.
FALK CORP.
Farrel-Birmingham Co., Inc.
Farrell-Cheek Steel Co.
Frog, Switch & Mfg. Co.
Gibraltar Equipment & Mfg. Co.
Jessop Steel Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Lebanon Steel Foundry
Los Angeles Steel Casting Co.
NATIONAL IRON CO.
NATIONAL MALLEABLE & STEEL CASTINGS CO.
Sorel Steel Foundries, Ltd.
Sterling Steel Casting Co.
Stroh Process Steel Co.
Strong Steel Foundry Co.
Taylor-Wharton Co. Div. Harsco Corp.
Thomas Foundries, Inc.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
Washington Iron Works

CHAIN, CAST & WELDED

American Brake Shoe Co. American Manganese Steel Div.
American Chain Div. American Chain & Cable Co., Inc.
Bridgeport Chain & Mfg. Co.
Chain Belt Co.
Electric Steel Foundry Co.
Farrell-Cheek Steel Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kensington Steel Co.
LINK-BELT CO.
McNally Pittsburg Mfg. Corp.
Morse Chain Co.
NATIONAL MALLEABLE & STEEL CASTINGS CO.
Olds Alloy Co.
Paulsen-Webber Cordage Corp.
Republic Steel Corp.
Ryerson & Son, Inc., Joseph T.
Taylor Chain Co. Inc., S.G.
Taylor-Wharton Co. Div. Harsco Corp.
Union Chain & Mfg. Co.

CHAIN, POWER TRANSMISSION

Atlas Chain & Mfg. Co.
Bartlett & Snow Co., C. O.
Browning Mfg. Co.
Chain Belt Co.
Christian Engineers, J. D.
Continental Gin Co. Industrial Div.
Cullman Wheel Co.
Diamond Chain Co., Inc.
Dick Co., R. & J.
Dodge Mfg. Corp.
Jeffrey Mfg. Co.
LINK-BELT CO.
McNally Pittsburg Mfg. Corp.
Morse Chain Co., A Borg-Warner Industry
Olds Alloy Co.
Union Chain & Mfg Co.
Whitney Chain Co.

CHAIN FITTINGS & ACCESSORIES

American Chain Div. American Chain & Cable Co., Inc.
American Hoist & Derrick Co.
Chain Belt Co.
Diamond Chain Co., Inc.
Electric Steel Foundry Co.
Farrell-Cheek Steel Co.
Hayes Steel Products, Ltd.
Interstate Drop Forge Co.
Jeffrey Mfg. Co.
Kensington Div., Poor & Co.
Lebus Mfg. Co. Subsidiary of American Hoist & Derrick Co.
LINK-BELT CO.
Madesco Tackle Block Co.
Newhall Chain Forge & Iron Co.
Paulsen-Webber Cordage Corp.
Republic Steel Corp.
Taylor Chain Co. Inc., S. G.
Taylor-Wharton Co. Div. Harsco Corp.
Union Chain & Mfg. Co.
Webb Co., Jervis B.

CHAIN SLINGS

American Brake Shoe Co.
American Chain Div. American Chain & Cable Co., Inc.
Electric Steel Foundry Co.
Manning, Maxwell & Moore, Inc. Shaw Box Crane & Hoist Div.
McMillan's Sons, W. H.
Newhall Chain Forge & Iron Co.
Paulsen-Webber Cordage Corp.
Republic Steel Corp.
Ryerson & Son, Inc., Joseph T.
Taylor Chain Co. Inc., S. G.

(CHAIN SPROCKETS — see Gears)

CHANGE ROOM EQUIPMENT

Moore Co.

CHEMICAL LABORATORY EQUIPMENT & SUPPLIES —does not include Chemicals; also see: Meters, Laboratory & Scientific Instruments other than . . . etc.

Bartlett & Snow Co., C. O.
Central Scientific Co.
Corning Glass Works
Fisher Scientific Co.
Jarrell-Ash Co.
Leeds & Northrup Co.
Snyder & Son, Inc., M. L.
Van Waters & Rogers, Inc.

CHEMICALS — also see: Flotation Reagents; Water Treatment Chemicals

Aluminum Co. of America
AMERICAN CYANAMID CO., EXPLOSIVES & MINING CHEMICALS DEPT.
American Sand-Banum Co., Inc.
Armour & Co.
Atlas Powder Co.
Baker Chemical Co., J. T.
Baker & Adamson Products, General Chemical Div., Allied Chemical Corp.
Belmont Smelting & Refining Works, Inc.
Canadian Industries Ltd.
Commercial Solvent Corp.
Dow Chemical Co.
DuPont de Nemours & Co., E. I.
DuPont de Nemours & Co., Inc. E. I. Explosives Dept.
Emery Industries, Inc.
Farbwerke Hoechst, A. G.
Fisher Scientific Co.
Food Machinery & Chemical Corp. Westvaco Mineral Products Div. Westvaco Chlor-Alkali Div.
Fuel Process Co.
Hagan Chemicals & Controls, Inc. Divisions: Calgon Co., Hall Laboratories
General Mills, Inc.
HERCULES POWDER CO.
Mallinckrodt Chemical Works
Marathon Corp.
Metal & Thermit Corp.
MONSANTO CHEMICAL CO.
Oronite Chemical Co.
Pacific Lumber Co.
Pennsalt Chemicals Corp.
Phelps Dodge Refining Corp.
Philadelphia Quartz Co.
Reilly Tar & Chemical Corp.
Rohm & Haas Co.
Solvay Process Div. Allied Chemical Corp.
Stein, Hall & Co., Inc.
Texas Gulf Sulphur Co.
Union Carbide Chemicals Co. Union Carbide Corp.
U.S. STEEL CORP., CHEMICAL SALES DIV.
Van Waters & Rogers, Inc.
Wyandotte Chemicals Corp.

(CLASSIFIERS — see below; also see: Filters; Separators; Screens; Thickeners)

CLASSIFIERS, AIR, CENTRIFUGAL & SIMILAR — does not include Classifiers, Cyclone

Centrifugal & Mech. Industries, Inc.
Combustion Engineering, Inc. Raymond Div.
Dorr-Oliver, Inc.
HARDINGE CO., INC.
HUMPHREYS INVESTMENT CO. ENGINEERING DIV.
Kennedy-Van Saun Mfg. & Eng. Corp.
Majac Inc.
Sharples Corp.
Sturtevant Mill Co.
Telluride Iron Works Co.
Universal Road Machinery Co.

CLASSIFIERS, BELT

Acme Road Machinery Co., Inc.
Bodinson Manufacturing Co., Inc.
DENVER EQUIPMENT CO.
HARDINGE CO., INC.
HEWITT-ROBINS, INC.
Jeffrey Mfg. Co.
LINK-BELT CO.
Meckum Engineering, Inc.
MINE & SMELTER SUPPLY CO., MFG. DIV.
Rogers Iron Works Co.
Telluride Iron Works Co.
Washington Machinery Co.

CLASSIFIERS, BOWL

Acme Road Machinery Co., Inc.
Dorr Oliver, Inc.
LINK-BELT CO.
Meckum Engineering, Inc.
Sharples Corp.

CLASSIFIERS, CYCLONE, DRY

BUELL ENGINEERING CO.
Convair, Inc.
Drilling Accessory & Mfg. Co., Inc.
DUCON, INC.
Hazemag m. b. H.
Kennedy-Van Saun Mfg. & Eng. Corp.
Kirk & Blum Mfg. Co.
Sturtevant Mill Co.

CLASSIFIERS, CYCLONE, WET

Atlantic Tank Corp.
Centrifugal & Mech. Industries, Inc.
DENVER EQUIPMENT CO.
Dorr Oliver, Inc.
EQUIPMENT ENGINEERS INC.
Georgia Iron Works Co.
Heyl & Patterson, Inc.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
McNally Pittsburg Mfg. Corp.
Prins & Associates, K.
Roberts & Schaefer Co., Subsidiary of Thompson Starrett Co., Inc.
Smith Engineering Works
Telluride Iron Works Co.

CLASSIFIERS, HYDRAULIC FLOW SETTLING

Cannon Concentrator Co.
Deister Concentrator Co.
Deister Machine Co.
DENVER EQUIPMENT CO.
Eagle Iron Works
HARDINGE CO., INC.
Heyl & Patterson, Inc.
Meckum Engineering, Inc.
MINE & SMELTER SUPPLY CO. MARCY MILL DIV.
Roberts & Schaefer Co., Subsidiary of Thompson Starrett Co., Inc.
Smith Engineering Works
WESTERN MACHINERY CO.

CLASSIFIERS, HYDRAULIC CENTRIFUGAL (CENTRIFUGES, ET AL)—does not include Classifiers, Cyclone

Bird Machine Co.
Centrifugal & Mech. Industries, Inc.
MINE & SMELTER SUPPLY CO., MFG. DIV.
Condenser Service & Engineering Co.
Deister Concentrator Co.
Deister Machine Co.
DENVER EQUIPMENT CO.
Dorr-Oliver, Inc.
Fahrenwald Co., A. W.
Heyl & Patterson, Inc.
LINK-BELT CO.
Meckum Engineering, Inc.
Sharples Corp.

CLASSIFIERS, RAKE

Bodinson Manufacturing Co., Inc.
DENVER EQUIPMENT CO.
Dorr-Oliver, Inc.
HARDINGE CO., INC.
Hirsch Bros. Machy. Co.
LINK-BELT CO.
Lippmann Engineering Works, Inc.
Morse Bros. Machinery Co.
Washington Machinery Co.

CLASSIFIERS, SPIRAL-SCREW (MECHANICAL)

Acme Road Machinery Co., Inc.
Canadian Locomotive Co., Ltd.
DENVER EQUIPMENT CO.
Eagle Iron Works
Hirsch Bros. Machy. Co.
LINK-BELT CO.
Lippmann Engineering Works, Inc.
McLanahan & Stone Corp.
MINE & SMELTER SUPPLY CO. MARCY MILL DIV.
MINE & SMELTER SUPPLY CO., MFG. DIV.
Pioneer Engineering Div., Poor & Co. Inc.
Rogers Iron Works Co.
Sharples Corp.
Smith Engineering Works
Straub Mfg. Co.
WESTERN MACHINERY CO.

(CLOCKS—see Meters, Time)

CLOTH & FABRICS—also see: Bags; Brattice Cloth, Filter Cloth, Insulation Cloth; Tarpaulins, Ventilation Tubing; Wire Cloth

Albany Felt Co.
AMERICAN BRATTICE CLOTH CORP.
COLORADO FUEL & IRON CORP.
Daniels, Inc., C. R.
DuPont de Nemours & Co., Inc. E. I. Fabrics Div.
EIMCO CORP.
Filtration Engineers, Inc. Sub. of Amer. Machine & Metals, Inc.
Gatke Corp.
HEWITT-ROBINS, INC.
House & Sons, Inc. Chas. W.
Irvington Div. Minnesota Mining & Mfg. Co.
Johns-Manville
Ludlow-Saylor Wire Cloth Co.
Multi-Metal Wire Cloth Co., Inc.
National Filter Media Corp.
Newark Wire Cloth Co.
Pendleton Woolen Mills
Safety Clothing & Equipment Co.
Snyder & Son, Inc., M. L.
Stanley Co., Inc., William W.
Turner Halsey Co.
Union Asbestos & Rubber Co.
U. S. Rubber Co.
Wellington Sears Co.
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.

(CLOTHING — see Safety Clothing)

(CLUTCHES, FLUID — see Drives, Fluid)

CLUTCHES, FRICTION

American Flexible Coupling Div. Zurn Industries, Inc.
Asbestos Mfg. Co.
Centric Clutch Co.
Dodge Mfg. Corp.
Eaton Mfg. Co.

Fawick Airflex Co., Inc.
Gatke Corp.
Jeffrey Mfg. Co.
LINK-BELT CO.
Marland One-Way Clutch Co.
Morse Chain Co. A Borg-Warner Industry
Twin Disc Clutch Co.
Wellman Co., S. K.

(CLUTCHES, MAGNETIC — see Drives, Magnetic)

(COATINGS, ABRASION-RESISTANT, METALLIC — see Hardfacing)

COATINGS, ABRASION-RESISTANT, NON-METALLIC —does not include Linings & Claddings

Aluminum Co. of America
Amercoat Corp.
Carboline Co.
Carey Mfg. Co., Philip
DENVER EQUIPMENT CO.
Dixon Crucible Co., Joseph
DePont de Nemours & Co., E. I.
Eagle-Picher Co.
Galigher Co.
Gates Engrg. Co.
Goodall Rubber Co.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co. Industrial Products
Master Bronze Powder Co., Inc.
Norton Co.
Permagile Corp. of America
Quaker Rubber Div. H. K. Porter Co., Inc.
Quigley Co., Inc.
Reilly Tar & Chemical Corp.
Rust-Oleum Corp.
Sauereisen Cement Co.
Sherwin-Williams Co.
Slip-On, Inc.
U. S. Rubber Co.
Wilbur & Williams Co.
Zophar Mills, Inc.

COATINGS, CHEMICAL & CORROSION - RESISTANT, METALLIC—also see Metalizing; does not include Linings & Claddings

Amercoat Corp.
Haynes Stellite Co.
Lincoln Electric Co.
Metallizing Engineering Co.
Wilbur & Williams Co.

COATINGS, CHEMICAL & CORROSION - RESISTANT, NON-METALLIC—does not include: Linings & Claddings; Paints

Amercoat Corp.
American Hard Rubber Co.
American Sand-Banum Co., Inc.
Armour Chemical Div.
Atlantic Refining Co.
Borne Chemical Co. Inc.
Cabot, Inc., Samuel
Carboline Co.
Carbolineum Wood Preserving Co.
Carey Mfg. Co., Philip
DENVER EQUIPMENT CO.
DuPont de Nemours & Co., E. I.
DuPont de Nemours & Co., E. I. Fabrics Div.
Eagle-Picher Co.
Engelhard Industries Inc.
Foster Co., L. B.
Galigher Co.
Gates Engrg. Co.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co. Industrial Products
Gulf Oil Corp.
Houghton & Co., E. F.
Irvington Div. Minnesota Mining Mfg. Co.
Johns-Manville
Keystone Lubricating Co.
Koppers Co. Inc
Luzerne Rubber Co.
Metal & Thermit Corp.
Minnesota Mining Mfg. Co.
MONSANTO CHEMICAL CO.
National Carbon Co. Union Carbide Corp.
Norton Co.
Pennsalt Chemicals Corp.
Permagile Corp. of America
Philadelphia Quartz Co.
Quaker Rubber Div. H. K. Porter Co., Inc.
Quigley Co. Inc.
Sauereisen Cement Co.
Sika Chemical Corp.
Slip-On, Inc.
Solvay Process Div. Allied Chemical & Dye Corp.
Sun Oil Co.
TEXAS CO.
U. S. Rubber Co.
Valvoline Oil Co. Div. Ashland Oil & Refining Co.
Wilbur Williams Co.
Zophar Mills, Inc.

COMMUNICATIONS, AUDIBLE SIGNAL (BELL, BUZZER, HORN, ETC.) — also see below

Falcon Alarm Co., Inc.
Federal Sign & Signal Corp.
Femco, Inc.
General Equipment Mfg. Co.
Graybar Elec. Co., Inc.
Lunkenheimer Co.
Partrick & Wilkins Co.
Talk-A-Phone Co.
Wheelco Instr. Div. Barber-Coleman Co.

COMMUNICATIONS, RADIO

Automatic Electric Co.
Elgin National Watch Co.
Federal Telephone & Radio Div. International Telephone and Telegraph Corp.
Femco, Inc.
General Equipment & Mfg. Co.
Graybar Elec. Co., Inc.
INDUSTRIAL PHYSICS & ELECTRONICS CO.
Motorola Communications Electronics, Inc.
National Mine Service Co.
Radio Corp. of America Communications Products Dept.
Spartan Air Services

COMMUNICATIONS, TELEPHONE

Ansonia Wire & Cable Co.
Automatic Electric Co.
Elgin National Watch Co.
Federal Telephone & Radio Div. International Telephone and Telegraph Corp.
Femco, Inc.
General Cable Corp.
Graybar Elec. Co., Inc.
Hose-McCann Telephone Co.
INDUSTRIAL PHYSICS & ELECTRONICS CO.
MINE SAFETY APPLIANCES CO.
Union Switch Signal Div., Westinghouse Air Brake Co.
Wheeler Electronic Corp., Div. Sperry Rand Corp.

COMMUNICATIONS, TELEVISION

Diamond Power Specialty Corp.
Elgin National Watch Co.
General Cable Corp.
General Equipment & Mfg. Co.
Graybar Elec. Co., Inc.
Kin Tel, Div. of Cohu Electronics, Inc.
Taller & Cooper, Inc.

COMMUNICATIONS, VISUAL SIGNAL (LIGHTS, SEMAPHORE, ETC.)—also see above and Rail Signals; does not include Signs)

AMERICAN MINE DOOR CO.
CHEATHAM ELECTRIC SWITCHING DEVICE CO.
Federal Sign & Signal Corp.
General Equipment & Mfg. Co.
Graybar Elec. Co., Inc.
National Filter Media Corp.
Nachod U. S. Signal Co.
Union Switch & Signal Div., Westinghouse Air Brake Co.

(COMPRESSORS — see Air Compressors)

COMPUTING MACHINES—does not include slide rules (see Drafting Equip.)

Remington Rand Div. Sperry Rand Corp.

(CONCENTRATORS — see Separators)

CONCRETE ADDITIVES (DISPERSANTS, ANTIFREEZE, ETC.)

Canadian Industries Ltd.
Dewey & Almy Chemical Co., Div. W. R. Grace & Co.
Dow Chemical Co.
HERCULES POWDER CO.
Heyl & Patterson, Inc.
Johns-Manville
Master Builders Co.
MONSANTO CHEMICAL CO.
Sika Chemical Corp.
Wyandotte Chemicals Corp.

CONCRETE GROUT PUMPS

Drilling Accessory & Mfg. Co., Inc.
Koehring Co.
Prehy Co.
MAYO TUNNEL & MINE EQUIPMENT
Pickard Industries, Inc. Central Mine Supply Co., Div.

CONCRETE (& similar material) PUMPS, SLINGERS & PLACERS

Air Placement Equip. Co.
Chain Belt Co.
Chicago Pneumatic Tool Co.
Herold Mfg. Co.
Prehy Co.

CONCRETE SPRAYERS & BLOWERS

Air Placement Equip. Co.
Cement Gun Co.
Engineered Equipment Inc.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Prehy Co.

(CONDENSERS—see Coolers)

(CONSULTANTS—see: Contractors; Laboratory Service; also see p. 261)

CONTINUOUS MINERS & PLANERS—also see: Drills (Rock) Special Large; does not include Cutting Machines; for bits see Cutting Machine Bits

Compton, Inc.
Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Lee-Norse Co.
National Mine Service Co.
Salem Tool Co.
Westfalia Lunen
Westinghouse Air Brake Co.
Wilcox Mfg. Co.

CONTRACTORS, AERIAL SURVEY (EXPLORATION, MAPPING, ETC.)

Abrams Aerial Survey Corp.
AERO SERVICE CORP.
Aero Service Corp. de Venezuela, C. A.
African Surveys (Pty.), Ltd.
American Air Surveys, Inc.
Ammann Photogammetric Engineers, Inc., Jack
Canadian Aero Service Ltd.
Cummings Jr., & Associates, Robt. A.
Fairchild Aerial Surveys, Inc.
Hunting Technical & Exploration Services Ltd.
Laylander, Philip A.
Nuclear Exploration Co.
Resources Development Corp.
Spartan Air Services

CONTRACTORS, CONSTRUCTION, MINERAL PROCESSING PLANT

Bechtel Corp.
CARPCO MANUFACTURING, INC.
Catalytic Construction Co.
Daniels Co. Contractors, Inc.
Elgin Corp.
Hack Engineering Co.
Industrial Engrg. & Construction Co.
Kaiser Engineers
McDowell Co., Inc.
McKee & Co., Arthur G.
Minerals Engineering Co.
NATIONAL IRON CO.
Southwestern Engineering Co.
STEARNS ROGER MFG. CO.
Stone & Webster Engineering Co.
Telluride Iron Works Co.
Universal Dredge Mfg. Co.
Walvoord, Inc., O. W.
WESTERN MACHINERY CO.
Winston Bros. Co.

CONTRACTORS, CONSTRUCTION, PIERS & WHARVES, ORE HANDLING, ET AL.

DeLong Engineering Corp.
Southwestern Engineering Co.

CONTRACTORS, CONSTRUCTION, SHAFT & TUNNEL

BOYLES BROS. DRILLING CO. (UTAH)
Coal State Construction Co.
Dravo Corp.
Elgin Corp.
Fitz Simons & Cornell Dredge & Dock Co.
Frazier Davis Construction Co.
Johnson Co., R. G.
Kaiser Engineers
McKenzie & Whittle
McKinney Drilling Co.
Pennsylvania Drilling Co.
Shaft & Development Machines Inc.
Shaft Constructors, Inc.
Soros, Paul
Stone & Webster Engineering Co.
Utah Construction Co.
Winston Bros. Co.

CONTRACTORS, DESIGN, MINE

Chapman, Wood & Griswold
Hack Engineering Co.
Herold Mfg. Co.
Industrial Engrg. & Construction Co.
Kaiser Engineers
Menlo Research Laboratory
Southwestern Engineering Co.
STEARNS ROGER MFG. CO.
Stone & Webster Engineering Co.
Telluride Iron Works Co.
Universal Dredge Mfg. Co.
Walwoord, Inc., O. W.
WESTERN MACHINERY CO.
Winston Bros. Co.

CONTRACTORS, DESIGN, MINERAL PROCESSING PLANT

Bartlett & Snow Co., C. O.
CARPCO MANUFACTURING, INC.
Catalytic Construction Co.
Daniels Co. Contractors, Inc.
DENVER EQUIPMENT CO.
GOULD CO., GORDON I.
Hack Engineering Co.
Kaiser Engineers
Kellogg Co., M. W.
McKee & Co., Arthur G.
Menlo Research Laboratory
Minerals Engineering Co.
Southwestern Engineering Co.
STEARNS ROGER MFG. CO.
Stone & Webster Engineering Co.
TREADWELL CO., M. H.
Universal Dredge Mfg. Co.
Vitro Corp. of America
Walvoord, Inc., O. W.

CONTRACTORS, DRILLING (EXPLORATION)

Acker Drill Co.
Black Diamond Spade Co.
Booth Co.
BOYLES BROS. DRILLING CO., LTD.
BOYLES BROS. DRILLING CO. (UTAH)
Brosites Products Corp.
CARPCO MANUFACTURING, INC.
Chapman & Wood
HOFFMAN BROS. DRILLING CO.
Joy Mfg. Co.
Manu-Mine Research & Devel. Co.
McDonald Drilling Co., Inc.
McKinney Drilling Co.
Minerals Engineering Co.
Mobile Drilling & Engineering Inc., Div. Mobile Drilling Inc.
MOBILE DRILLING INC.
Mott Core Drilling Co.
Nuclear Exploration Co.

Pennsylvania Drilling Co.
SPRAGUE & HENWOOD, INC.
WESTERN MACHINERY CO.
Winston Bros. Co.

CONTRACTORS, GEOLOGICAL SERVICE

Abrams Aerial Survey Corp.
AERO SERVICE CORP.
Aero Service Corp. de Venezuela C. A.
African Surveys (Pty.) Ltd.
American Air Surveys, Inc.
Canadian Aero Service Ltd.
Chapman & Wood
Engineers Syndicate, Ltd.
GOULD CO., GORDON I.
Hunting Technical & Exploration Services Ltd.
Hycon Aerial Surveys, Inc.
Laylander, Philip A.
McPhar Geophysics, Ltd.
MOBILE DRILLING, INC.
Mobile Drilling & Engineering Inc., Div. Mobile Drilling Inc.
Nuclear Exploration Co.
Pennsylvania Drilling Co.
Resources Development Corp.
Spartan Air Services

CONTRACTORS, GEOPHYSICAL SERVICE

American Air Surveys, Inc.
Engineers Syndicate, Ltd.
Fairchild Aerial Surveys, Inc.
Hunting Technical & Exploration Services Ltd.
Hycon Aerial Surveys, Inc.
Lundberg Explorations, Ltd.
McPhar Geophysics, Ltd.
Nuclear Exploration Co.
Resources Development Corp.
Seismograph Service Corp.
Spartan Air Services

CONTRACTORS, GROUND SOLIDIFICATION & CEMENTATION

Pennsylvania Drilling Co.

(CONTRACTORS, LABORATORY & TESTING SERVICE—see Lab. Service)

CONTRACTORS, MAPPING (TOPO)

AERO SERVICE CORP.
African Surveys (Pty.), Ltd.
American Air Surveys, Inc.
Ammann Photogrammetric Engineers, Inc. Jack
Canadian Aero Service Ltd.
Chapman & Wood
Cummings Jr., & Associates, Robt. A.
Fairchild Aerial Surveys, Inc.
Gurley, W. & L. E.
Hunting Technical & Exploration Services Ltd.
Hycon Aerial Surveys, Inc.
Spartan Air Services

CONTRACTORS, MINE & PROSPECT EXAMINATION & VALUATION—also see Consultants

GOULD CO., GORDON I.
Pennsylvania Drilling Co.

CONTRACTORS, MINING, DREDGING

Fitz Simons & Connell Dredge & Dock Co.
Hack Engineering Co.
Universal Dredge Mfg. Co.
Winston Bros. Co.

CONTRACTORS, MINING, OPEN PIT

Fitz Simons & Connell Dredge & Dock Co.
Foley Bros. Construction Co.
Hack Engineering Co.
Hales Co., W. M.
Minerals Engineering Co.
Southwestern Engineering Co.
Universal Dredge Mfg. Co.
Utah Construction Co.
Winston Bros. Co.

CONTRACTORS, MINING, STRIPPING

Fitz Simons & Connell Dredge & Dock Co.
Hack Engineering Co.
Hales Co., W. M.
Minerals Engineering Co.
Universal Dredge Mfg. Co.
Winston Bros. Co.

CONTRACTORS, MINING, UNDERGROUND

BOYLES BROS. DRILLING CO. (UTAH)
Fitz Simons & Connell Dredge & Dock Co.
Frazier Davis Construction Co.
Hack Engineering Co.
Hales Co., W. M.
Minerals Engineering Co.
Universal Dredge Mfg. Co.
Winston Bros. Co.

CONTROLS, ELECTRICAL & ELECTRONIC (AUTOMATIC, REMOTE, INDICATING, RECORDING, ETC)—also see: Meters; Communications

ABCs Scale Div. McDowell Co., Inc.
Aerofall Mills, Inc.
Allen-Bradley Co.
Allis-Chalmers Mfg. Co. Industries Group
Allis Co., Louis
American Instrument Co., Inc.
American Rectifier Corp.
Arrow Hart & Hegeman Electric Co.
Assembly Products, Inc.
Auto-Lite Battery Corp.
Automatic Electric Co.
Automatic Switch Co.
Bailey Meter Co.
Beckman Instruments, Inc., Process Instruments Div.
BIN-DICATOR CO.
Bristol Co.
Builders-Providence Div. B-I-F Industries
Chatillon & Sons, John
CHEATHAM ELECTRIC SWITCHING DEVICE CO.
Clark Controller Co.
Consolidated Electrodynamics Corp.
Control Corp.
Convair, Inc.
Cutler-Hammer, Inc.
Dietz Co., Henry G.
Electric Controller & Mfg. Co. Div. Square D Co.
Electro Products Laboratories
Elgin National Watch Co.
Ensign Electric & Mfg. Co.
Erie Strayer Co.
Falcon Alarm Co., Inc.
Federal Pacific Electric Co.
Femco, Inc.
Fischer & Porter Co.
Foxboro Co.
General Electric Co. Apparatus Sales Div.
General Equipment & Mfg. Co.
Graybar Elec. Co., Inc.
Hagan Chemicals & Controls, Inc. Divisions: Calgon Co., Hall Laboratories
HARDINGE CO., INC.
Hart Mfg. Co.
Illinois Testing Laboratories, Inc.
INDUSTRIAL PHYSICS & ELECTRONICS CO.
Infilco, Inc.
Isotope Products, Inc. Instrument Div.
Johnson Corp.
Kurz & Root Co.
Ledeen, Inc.
Leeds & Northrup Co.
Minneapolis-Honeywell Regulator Co.
Minneapolis Honeywell Regulator Co. Brown Instrument Div.
Minneapolis-Honeywell Regulator Co. Industrial Div.
Minneapolis-Honeywell Regulator Co. Micro Switch Div.
Nachod & U. S. Signal Co.
National Filter Media Corp.
Norden-Ketay Corp.
Nuclear Research Corp.
Ohio Electric Mfg. Co.
Paragon Electric Co.
Permutit Co., Div. Pfaudler Permutit Inc.
Philips Electronics, Inc. Instruments Div.
Pittsburgh Electrical & Machine Works
Preco, Inc.
Pyle-National Co.
Reliance Electric & Engineering Co.
Republic Flow Meters Co.
Revere Corp. of America
Richards-Wilcox Mfg. Co.
Richardson Scale Co.
Sangamo Electric Co.
Streeter-Amet Co.
Taller & Cooper, Inc.
Texas Instruments, Inc. Industrial Instrumentation Div.
Trombetta Solenoid Corp.
Union Switch & Signal Div., Westinghouse Air Brake Co.
Webb Co., Jervis B.
Westinghouse Electric Corp.
Weston Instruments, Div. Daystrom, Inc.
Whelco Instr. Div. Barber-Colman Co.

(CONTROLS, ELECTRIC MOTOR—see Electric Motor Controls)

CONTROLS, HYDRAULIC & PNEUMATIC (AUTO. REMOTE, ETC.) — also see Meters

ABCs Scale Div. McDowell Co., Inc.
American Chain & Cable Co., Inc. Automotive & Aircraft Div.
American Instrument Co., Inc.
Automatic Switch Co.
Bailey Meter Co.
Barksdale Valves
Black, Sivalls & Bryson, Inc.
Bristol Co.
Builders-Providence Div. B-I-F Industries
Cash Co., A. W.
Clark Controller Co.
Fischer & Porter Co.
Foxboro Co.
General Equipment & Mfg. Co.
Hagan Chemicals & Controls, Inc. Divisions: Calgon Co., Hall Laboratories
Hunt Son, Inc., C. B.
INDUSTRIAL PHYSICS & ELECTRONICS CO.
Infilco, Inc.
Jordan Corp., Div. OPW Corp.
Ledeen, Inc.
Leeds & Northrup Co.
Minneapolis-Honeywell Regulator Co.
Minneapolis Honeywell Regulator Co. Brown Instrument Div.
Minneapolis-Honeywell Regulator Co. Industrial Div.
Oilgear Co.
Owatonna Tool Co.
Permutit Co., Div. Pfaudler Permutit Inc.
Pittsburgh Electrical & Machine Works
Republic Flow Meters Co.
Taller & Cooper, Inc.
U. S. Guage Div., American Machine & Metals, Inc.
Vickers Inc.
Westinghouse Air Brake Co.
Westinghouse Air Brake Co. Ind. Products Div.

CONVERTERS, METAL (equipment not service)

Allis-Chalmers Mfg. Co. Industries Group
TRAYLOR ENGINEERING & MFG. CO.
Telluride Iron Works Co.
TREADWELL CO., M. H.

CONVEYOR BELTING

Acme Road Machinery Co., Inc.
Acme Rubber Mfg. Co.
American Rubber Mfg. Co.
Bonded Scale & Machine Co.
Boston Woven Hose & Rubber Co.
Cambridge Wire Cloth Co.
Carlyle Rubber Co.
Chicago Belting Div. Chicago-Allis Mfg. Corp.
Colorado Fuel & Iron Corp. Wickwire Spencer Steel Div.
Daniels, Inc., C. R.
Dick Co., R. & J.
Gibraltar Equipment & Mfg. Co.
Goodall Rubber Co.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co.
Hamilton Rubber Mfg. Corp.
HEWITT-ROBINS, INC.
Missouri Belting Co.
National Mine Service Co.
New York Belting & Packing Co.
New York Rubber Corp.
Northern Conveyor Co.
Philadelphia Belting Co.
Paltech Co.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Pioneer Engineering Div., Poor & Co. Inc.
Quaker Rubber Div. H. K. Porter Company, Inc.
Raybestos-Manhattan, Inc. Manhattan Rubber Div.
Republic Rubber Div. Lee Rubber & Tire Corp.
Richardson Scale Co.
Sandvik Steel Inc. Steel Belt Conveyor Dept.
Scandinavia Belting Co.
Specialty Engineering Co.
Thermoid Co. Industrial Div.
U. S. Rubber Co.
U. S. Rubber Co. Mechanical Goods Div.
Webb Belting & Supply Co.
West Virginia Belt Repairs, Inc.
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.

CONVEYOR BELTING FASTENERS

Acme Road Machinery Co., Inc.
American Rubber Mfg. Co.
Armstrong, Bray & Co.
Clipper Belt Lacer Co.
Crescent Belt Fastener Co., Inc.
Daniels, Inc., C. R.
Dick Co., R. & J.
Flexible Steel Lacing Co.
General Splice Corp.
Goodall Rubber Co.
HEWITT-ROBINS INC.
National Mine Service Co.
Northern Conveyor Co.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Raybestos-Manhattan, Inc., Manhattan Rubber Div.
Sawyer Belt Hook & Wedge Co., Inc.
Talcott, Inc.
Webb Belting & Supply Co.
West Virginia Belt Repairs, Inc.

CONVEYOR BELTING VULCANIZERS

Flexible Steel Lacing Co.
Food Machinery & Chemical Corp. Packing Equipment Div.
Goodrich Industrial Products Co., B. F.
Heintz Mfg. Co.
West Virginia Belt Repairs, Inc.

(CONVEYORS — see below; also see Loaders; Feeders)

(CONVEYORS, APRON — see Conveyors, Pan)

CONVEYORS, BELT—for belting alone, see Conveyor Belting

ABCs Scale Div. McDowell Co., Inc.
Acme Road Machinery Co., Inc.
American Conveyor Co.
American Rubber Mfg. Co.
Atlas Conveyor Co.
Baldwin-Lima-Hamilton Corp. Construction Equipment Div.
Barber-Greene Co.
Bartlett & Snow Co., C. O.
Bodinson Manufacturing Co., Inc.
Bonded Scale & Machine Co.
Boston Woven Hose & Rubber Co.
Cambridge Wire Cloth Co.
CARPCO MANUFACTURING, INC.
Chain Belt Co.
Christian Engineers, J. D.
Cincinnati Rubber Mfg. Co. Div. Thor Power Tool Co.
Columbus Conveyor Co.
Compton, Inc.
Continental Gin Co. Industrial Div.
Conveyor Systems, Inc.
Davis Foundry & Machine Works
Diamond Iron Works Div. Goodman Mfg. Co.
Galigher Co.
Gruendler Crusher & Pulverizer Co.
Hack Engineering Co.
Herold Mfg. Co.
HEWITT-ROBINS, INC.
Heyl & Patterson, Inc.
Hirsch Bros. Machy. Co.
Industrial Engrg. & Construction Co.
IOWA MFG. CO.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kremser & Sons, Inc. Frank A.
Lake Shore, Inc. Lake Shore Engineering Div.
Lamson Corp.
LINK-BELT CO.
Lippman Engineering Works, Inc.
Long Co.
Marsh Engineering Co., E. F.
MAYO TUNNEL & MINE EQUIPMENT
McNally Pittsburg Mfg. Corp.

Mekum Engineering, Inc.
Morse Bros. Machinery Co.
Northern Conveyor Co.
Ogden Iron Works
Oliver Corp. A. B. Farquhar Div.
Philadelphia Belting Co.
Pioneer Engineering Div. Poor & Co. Inc.
Quaker Rubber Div. H. K. Porter Co. Inc.
Richardson Scale Co.
Rogers Iron Works Co.
Sandvik Steel Inc. Steel Belt Conveyor Dept.
Savage Co., W. J.
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
Sturtevant Mill Co.
U. S. Rubber Co. Mechanical Goods Div.
Universal Dredge Mfg. Co.
Universal Road Machinery Co.
Washington Machinery Co.
Webb Belting & Supply Co.
Webb Co., Jervis B.
Webster Mfg., Inc.
Yuba Consolidated Industries, Inc.

CONVEYORS, BELT, ACCESSORIES (Cleaners, Moldboards, etc.)

Osborn Mfg. Co.

CONVEYORS, BELT, HOLDBACKS

Bonded Scale & Machine Co.
HEWITT-ROBINS, INC.
LINK-BELT CO.
Marland One-Way Clutch Co.
Stephens-Adamson Mfg. Co.

CONVEYORS, BELT, IDLERS & PULLEYS

Acme Road Machinery Co., Inc.
American Pulley Co.
Atlas Conveyor Co.
Barber-Greene Co.
Bartlett & Snow Co., C. O.
Bodinson Manufacturing Co., Inc.
Bonded Scale & Machine Co.
Chain Belt Co.
Christian Engineers, J. D.
Columbus Conveyor Co
Continental Gin Co. Industrial Div.
Davis Foundry & Machine Works
DENVER EQUIPMENT CO.
Diamond Iron Works Div Goodman Mfg. Co.
Dick Co., R. & J.
Dodge Mfg. Corp.
Food Machinery & Chemical Corp. Packing Equipment Div.
Galigher Co.
Goodyear Tire & Rubber Co.
Hack Engineering Co.
HEWITT-ROBINS, INC.
Heyl & Patterson, Inc.
IOWA MFG. CO.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Kremser & Sons, Inc, Frank A.
Lamson Corp.
LINK-BELT CO.
Lippmann Engineering Works. Inc.
Long Co.
Marsh Engineering Co., E. F.
McNally Pittsburg Mfg. Corp.
Northern Conveyor Co.
Ogden Iron Works
Osborn Mfg. Co.
Pettibone Mulliken Corp.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Pioneer Engineering Div. Poor & Co. Inc.
Ridge Equipment Co.
Rogers Iron Works Co.
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
U. S. Rubber Co. Mechanical Goods Div.
Van Gorp Mfg., Inc.
Washington Machinery Co.
Universal Dredge Mfg. Co.
Washington Machinery Co.
Webb Belting & Supply Co.
Webb Co., Jervis B.
Webster Mfg., Inc.
Wood's Sons Co., T. B.
Yuba Consolidated Industries, Inc.

CONVEYORS, BELT, TAKE-UPS

Acme Road Machinery Co., Inc.
Atlas Conveyor Co.
Barber-Greene Co.
Bartlett & Snow Co., C. O.
Bodinson Manufacturing Co., Inc.
Bonded Scale & Machine Co.
Chain Belt Co.
Christian Engineers, J. D.
Columbus Conveyor Co.
CONNELLSVILLE MFG. & MINE SUPPLY CO.
Continental Gin Co. Industrial Div.
Dodge Mfg. Corp.
Food Machinery & Chemical Corp. Packing Equipment Div.
Hack Engineering Co.
HEWITT-ROBINS, INC.
Heyl & Patterson, Inc.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Kremser & Sons, Inc. Frank A.
LINK-BELT CO.
Lippmann Engineering Works, Inc.
Marsh Engineering Co., E. F.
McNally Pittsburg Mfg. Corp.
Ogden Iron Works
Pickard Industries, Inc. Central Mine Supply Co., Div
Pioneer Engineering Div. Poor & Co. Inc.
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
Universal Dredge Mfg. Co.
Washington Machinery Co.
Webb Belting & Supply Co.
Webster Mfg., Inc.
Yuba Consolidated Industries, Inc.

CONVEYORS, BELT, TRIPPERS

Bartlett & Snow Co., C. O.
Bodinson Manufacturing Co., Inc.
Bonded Scale & Machine Co.
Chain Belt Co.
Christian Engineers, J. D.
Columbus Conveyor Co.
CONNELLSVILLE MFG. & MINE SUPPLY CO.
Continental Gin Co. Industrial Div.
Hack Engineering Co.
HEWITT-ROBINS, INC.
Heyl & Patterson, Inc.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Lamson Corp.
LINK-BELT CO.
Lippmann Engineering Works, Inc.
Marsh Engineering Co., E. F.
McNally Pittsburg Mfg. Corp.
Ogden Iron Works
Oliver Corp. A. B. Farquhar Div.
Stephens-Adamson Mfg. Co.
Universal Dredge Mfg. Co.
Webb Belting & Supply Co.
Webb Co., Jervis B.
Webster Mfg., Inc.

CONVEYORS (& ELEVATORS), BUCKET—does not include: Conveyors, Trolley; or digging type (see Loaders)

Acme Road Machinery Co., Inc.
American Conveyor Co.
Atlas Conveyor Co.
Barber-Greene Co.
Bonded Scale & Machine Co.
Butler Bin Co.
Butler Mfg. Co.
CARPCO MANUFACTURING, INC.
Chain Belt Co.
Christian Engineers, J. D.
Columbus Conveyor Co.
Continental Gin Co. Industrial Div.
Conveyor Systems, Inc.
DENVER EQUIPMENT CO.
Engineered Equipment Inc.
Erie Strayer Co.
Fluor Products Co., Hartmann Div.
Galigher Co.
Gruendler Crusher & Pulverizer Co.
Hack Engineering Co.
Hapman Conveyors, Inc.
HEWITT-ROBINS, INC.
Hirsch Bros. Machy. Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Johnson Co., C. S.
Kanawha Mfg. Co.
Kremser & Sons, Inc. Frank A.
LINK-BELT CO.
Lippmann Engineering Works, Inc.
Marsh Engineering Co., E. F.
McNally Pittsburg Mfg. Corp.
Meckum Engineering, Inc.
Northern Conveyor Co.
Ogden Iron Works
Pickard Industries, Inc. Central Mine Supply Co., Div.
Pioneer Engineering Div. Poor & Co. Inc.
Richardson Scale Co.
Ridge Equipment Co.
Rogers Iron Works Co.
Smith Engineering Works
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
Sturtevant Mill Co.
Transport Trailers, Inc.
Union Chain & Mfg. Co.
Universal Dredge Mfg. Co.
Universal Road Machinery Co.
Savage Co., W. J.
Washington Machinery Co.
Webb Belting & Supply Co.
Webb Co., Jervis B.
Webster Mfg., Inc.
Yuba Consolidated Industries, Inc.,

CONVEYORS, CHAIN (PACKAGE)

Bodinson Manufacturing Co., Inc.
Bonded Scale & Machine Co.
Chain Belt Co.
Christian Engineers, J. D.
Compton, Inc.
Conveyor Systems, Inc.
Electric Steel Foundry Co.
Erie Strayer Co.
Food Machinery & Chemical Corp.
Hapman Conveyors, Inc.
Hirsch Bros. Machy. Co
Erwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kremser & Sons, Inc. Frank A.
LINK-BELT CO.
Lippmann Engineering Works, Inc.
Long Co.
Morse Chain Co.
Northern Conveyor Co.
Oliver Corp. A. B. Farquhar Div.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Richards-Wilcox Mfg. Co.
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
Union Chain & Mfg. Co.
Washington Machinery Co.
Watt Car & Wheel Co.
Webb Belting & Supply Co.
Webb Co., Jervis B.
Whitney Chain Co.

CONVEYORS, CHAIN (DRAG-SCRAPER), (BULK) — does not include: Dragline Scraper-Slusher; or digging type (see Loaders)

American Brake Shoe Co. American Manganese Steel Div.
Atlas Conveyor Co.
Bartlett & Snow Co., C. O.
Bethlehem Foundry & Machine Co.
Bodinson Manufacturing Co., Inc.
Bonded Scale & Machine Co.
Chain Belt Co.
Columbus Conveyor Co.
Compton, Inc.
Continental Gin Co. Industrial Div.
Conveyor Systems, Inc.
Goodman Mfg. Co.
Hack Engineering Co.
Hapman Conveyors, Inc.
Herold Mfg. Co.
Hirsch Bros. Machy. Co.
Holmes & Bros., Inc. Robert
Industrial Engrg. & Construction Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kremser & Sons, Inc. Frank A.
LINK-BELT CO.
Lippmann Engineering Works, Inc.
McNally Pittsburg Mfg. Corp.
Northern Conveyor Co.
Oliver Corp. A. B. Farquhar Div.
Ottumwa Box Car Loader Co.
Pettibone Mulliken Corp.
Prins & Associates, K.
Roberts & Schaefer Co., Subsidiary of Thompson Starrett Co., Inc.
SAUERMAN BROS., INC.
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
Union Chain & Mfg. Co.
U. S. Rubber Co. Mechanical Goods Div.
Universal Dredge Mfg. Co.
Webb Belting & Supply Co.
Webb Co., Jervis B.
Webster Mfg., Inc.

CONVEYORS, EXTENSIBLE

Industrial Engrg. & Construction Co.
Goodman Mfg. Co.
Joy Mfg. Co.
LINK-BELT CO.

CONVEYORS, LOADING BOOM & STACKER — does not include: small digging type (see Loaders); or Cranes, Overhead Traveling Gantry, Bridge, Monorail, Etc.

Bartlett & Snow Co., C. O.
Bonded Scale & Machine Co.
Hack Engineering Co.
Helmick Foundry-Machine Co.
LINK-BELT CO.
Universal Dredge Mfg. Co.
Pioneer Engineering Div., Poor & Co. Inc.
Rogers Iron Works Co.
Stephens-Adamson Mfg. Co.
Universal Dredge Mfg. Co.
Webb Co., Jervis B.

CONVEYORS, MOBILE (including Self-propelled) — does not include digging type (see Loaders)

Continental Gin Co. Industrial Div.
Hack Engineering Co.
HEWITT-ROBINS, INC.
Irwin Foundry & Mine Car Co.
Kremser & Sons, Inc. Frank A.
LINK-BELT CO.
Lippmann Engineering Works, Inc.
Long Co.
Northern Conveyor Co.
Universal Dredge Mfg. Co.
Webb Belting & Supply Co.

CONVEYORS MOVABLE, also see Conveyors, Mobile; does not include digging type (see Loaders)

American Conveyor Co.
American Pulley Co.
Baldwin-Lima-Hamilton Corp. Construction Equipment Div.
Barber-Greene Co.
Bonded Scale & Machine Co.
Carrier Conveyor Corp.
Chain Belt Co.
Continental Gin Co. Industrial Div.
Food Machinery & Chemical Corp. Packing Equipment Div.
Hack Engineering Co.
Herold Mfg. Co.
HEWITT-ROBINS, INC.
Industrial Engrg. & Construction Co.
Irwin Foundry & Mine Car Co.
Pettibone Mulliken Corp.
Joy Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Kremser & Sons, Inc. Frank A.
LINK-BELT CO.
Lippmann Engineering Works, Inc.
Marsh Engineering Co., E. F.
Oliver Corp.
Oliver Corp. A. B. Farquhar Div.
Ottumwa Box Car Loader Co.
Richards-Wilcox Mfg. Co.
Rogers Iron Works Co.
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
Universal Dredge Mfg. Co.
Webb Belting & Supply Co.
Wilcox Mfg. Co.

CONVEYORS, PAN & APRON

Acme Road Machinery Co., Inc.
American Brake Shoe Co. American Manganese Steel Div.
Bartlett & Snow Co., C. O.
Bodinson Manufacturing Co., Inc.
Bonded Scale & Machine Co.
Carrier Conveyor Corp.
Chain Belt Co.
Christian Engineers, J. D.
Columbus Conveyor Co.
CONNELLSVILLE MFG. & MINE SUPPLY CO.
Continental Gin Co. Industrial Div.
Conveyor Systems, Inc.
Diamond Iron Works Div. Goodman Mfg. Co.
Fluor Products Co., Hartmann Div.
Food Machinery & Chemical Corp. Packing Equipment Div.
Gruendler Crusher & Pulverizer Co.
Hack Engineering Co.
Hapman Conveyors, Inc.
Helmick Foundry-Machine Co.
Hendrick Mfg. Co.
Herold Mfg. Co.
HEWITT-ROBINS, INC.
Heyl & Patterson, Inc.
Hirsch Bros. Machy. Co.
Industrial Engrg. & Construction Co.
IOWA MFG. CO.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Kremser & Sons, Inc. Frank A.
LINK-BELT CO.
Lippmann Engineering Works, Inc.
Marsh Engineering Co., E. F.
Prins & Associates, K.
Lamson Corp.
MACHINERY CENTER INC.
McNally Pittsburg Mfg. Corp.
NATIONAL IRON CO.
Pioneer Engineering Div. Poor & Co. Inc.

Holmes & Bros., Inc. Robert
Ogden Iron Works
Pettibone Mulliken Corp.
Roberts & Schaefer Co., Subsidiary of Thompson Starrett Co., Inc.
Rogers Iron Works Co.
Simplicity Engineering Co.
Simplicity System Co.
Smith Engineering Works
Sorel Steel Foundries, Ltd.
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
Taylor-Wharton Co. Div. Harsco Corp.
Telluride Iron Works Co.
Union Chain & Mfg. Co.
Universal Dredge Mfg. Co.
Webb Belting & Supply Co.
Webb Co., Jervis B.
Webster Mfg., Inc.

CONVEYORS, PNEUMATIC

ALLEN-SHERMAN-HOFF CO.
Convair, Inc.
General American Transportation Corp.
Gruendler Crusher & Pulverizer Co.
Fluor Products Co., Hartmann Div.
Fuller Co., Subsidiary General American Transportation Corp.
Hack Engineering Co.
Hapman Conveyors, Inc.
Lamson Corp.
Metals Disintegrating Co., Inc. Pulverizing Machinery Div.
Robinson Air-Activated Conveyor Systems
Specialty Engineering Co.
Spencer Turbine Co.
Universal Dredge Mfg. Co.

CONVEYORS, ROLLER, GRAVITY & POWERED (PACKAGE)

American Conveyor Co.
American Pulley Co.
Bonded Scale & Machine Co.
Conveyor Systems, Inc.
Food Machinery & Chemical Corp. Packing Equipment Div.
Hapman Conveyors, Inc.
Lamson Corp.
LINK-BELT CO.
Lippmann Engineering Works, Inc.
Oliver Corp.
Oliver Corp. A. B. Farquhar Div.
Richards-Wilcox Mfg. Co.
Specialty Engineering Co.
Webb Belting & Supply Co.

CONVEYORS, SCREW OR SPIRAL

Atlas Conveyor Co.
Bartlett & Snow Co., C. O.
Bethlehem Foundry & Machine Co.
Bonded Scale & Machine Co.
Butler Bin Co.
Butler Mfg. Co.
Cambridge Wire Cloth Co.
CARPCO MANUFACTURING INC.
Chain Belt Co.
Christian Engineers, J. D.
Columbus Conveyor Co.
Continental Gin Co. Industrial Div.
Engineered Equipment Inc.
Erie Strayer Co.
Fluor Products Co., Hartmann Div.
Food Machinery & Chemical Corp. Packing Equipment Div.
Hack Engineering Co.
Hapman Conveyors, Inc.
Hirsch Bros. Machy. Co.
Holmes & Bros., Inc. Robert
Jeffrey Mfg. Co.
Johnson Co., C. S.
Kennedy-Van Saun Mfg. & Eng. Corp.
LINK-BELT CO.
McNally Pittsburg Mfg. Corp.
Meckum Engineering, Inc.
Northern Conveyor Co.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Pioneer Engineering Div., Poor & Co. Inc.
Richardson Scale Co.
Roberts & Schaefer Co., Subsidiary of Thompson Starrett Co., Inc.
Salem Tool Co.
Specialty Engineering Co.
Sturtevant Mill Co.
Universal Dredge Mfg. Co.
Washington Machinery Co.
Webb Belting & Supply Co.
Webster Mfg., Inc.

CONVEYORS, SECTIONAL PREFAB—does not include Conveyors, Movable

Acme Road Machinery Co., Inc.
Atlas Conveyor Co.
Barber-Greene Co.
Bonded Scale & Machine Co.
CONNELLSVILLE MFG. & MINE SUPPLY CO.
Continental Gin Co. Industrial Div.
Gruendler Crusher & Pulverizer Co.
Hack Engineering Co.
Hapman Conveyors, Inc.
HEWITT-ROBINS, INC.
Irwin Foundry & Mine Car Co.
Joy Mfg. Co.
Kremser & Sons, Inc. Frank A.
Lamson Corp.
LINK-BELT CO.
Lippmann Engineering Works, Inc.
Marsh Engineering Co., E. F.
Oliver Corp. A. B. Farquhar Div.
Pioneer Engineering Div., Poor & Co. Inc.
Rogers Iron Works Co.
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
Universal Dredge Mfg. Co.
Watt Car & Wheel Co.
Webb Belting & Supply Co.
Webb Co., Jervis B.

CONVEYORS, SHAKING & VIBRATING — also see Feeders

Ajax Flexible Coupling Co.
Atlas Conveyor Co.
Branford Co.
CARPCO MANUFACTURING, INC.
Carrier Conveyor Corp.
Chain Belt Co.
Conveyor Systems, Inc.
DIESEL ENERGY CORP.
Dravo Corp.
Goodman Mfg. Co.
Hack Engineering Co.
Herold Mfg. Co.
HEWITT-ROBINS, INC.
Heyl & Patterson, Inc.
Industrial Engrg. & Construction Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
LINK-BELT Co.
Overstrom & Sons, Inc.
Richardson Scale Co.
Ridge Equipment Co.
Simplicity Engineering Co.
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
Syntron Co.
Universal Dredge Mfg. Co.
Washington Machinery Co.
Webb Belting & Supply Co.

CONVEYORS, TROLLEY — does not include aerial Cableways

Conveyor Systems, Inc.
Eriez Mfg. Co.
Hapman Conveyors, Inc.
Lamson Corp.
LINK-BELT CO.
Louden Machinery Co.
Richards-Wilcox Mfg. Co.
Specialty Engineering Co.
Webb Co., Jervis B.
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.

COOLERS (& CONDENSERS), LIQUID & GAS PROCESS—does not include Air Compressor Aftercoolers

Alco Products, Inc.
Allis-Chalmers Mfg. Co. Industries Group
Canadian Locomotive Co., Ltd.
Carrier Corp.
Condenser Service & Engineering Co.
Curtis Manufacturing Co.
Foster Wheeler Corp.
Lilie-Hoffmann Cooling Towers, Inc.
Marley Co.
Ogden Iron Works
Process Engineering, Inc.
Ross Heat Exchanger Div. American Standard
Southwestern Engineering Co.
Yaun Mfg. Co., Inc.
Yuba Consolidated Industries, Inc.

COOLERS, SOLIDS

Allis-Chalmers Mfg. Co. Industries Group
Bartlett & Snow Co., C. O.
Carrier Conveyor Corp.
Christian Engineers, J. D.
Fuller Co., Subsidiary General
General American Transportation Corp.
Louisville Dryer Div.
HARDINGE CO. INC.
Kennedy-Van Saun Mfg. & Eng. Corp.
LINK-BELT CO.
NORDBERG MFG. CO.
SMIDTH & CO., F. L.
Standard Steel Corp.
STEARNS ROGER MFG. CO.
TRAYLOR ENGINEERING & MFG. CO.
VULCAN IRON WORKS
Western Precipitation Corp.
Yaun Mfg. Co., Inc.
Yuba Consolidated Industries, Inc.

(CORE BARRELS — see Drill (Rock Core Barrels)

(COUPLERS, MINE CAR—see Car Couplers)

(COUPLINGS — see below; also see: Drill Rod; Pipe Fittings)

(COUPLINGS, MECHANICAL POWER TRANSMISSION—see below; also see: Clutches; Drives; Hubs)

COUPLINGS, M. P. T., FLEXIBLE

Ajax Flexible Coupling Co.
American Flexible Coupling Co.
American Flexible Coupling Div. Zurn Industries, Inc.
Arrowhead Products Div. Federal-Mogul-Bower, Bearings Inc.
Browning Mfg. Co.
Chain Belt Co.
Continental Gin Co. Industrial Div.
Cullman Wheel Co.
Diamond Chain Co., Inc.
Dodge Mfg. Corp.
Elliott Co.
F. A. B. Mfg. Co.
FALK CORP.
Farrel-Birmingham Co., Inc.
Foote Bros. Gear & Machine Corp.
HEWITT-ROBINS, INC.
Jeffrey Mfg. Co.
Koppers Co., Inc. Metal Prod. Div.
LINK-BELT CO.
Lovejoy Flexible Coupling Co.
Marland One-Way Clutch Co.
Morse Chain Co. A Borg-Warner Industry
Philadelphia Gear Corp.
Poole Foundry & Machine Co.
Smith & Serrell, Inc.
Stratoflex, Inc.
Thomas Flexible Coupling Co.
Waldron Corp., John
Weatherhead Co. Fort Wayne Div.
Western Gear Corp.
Whitney Chain Co.
Wood's Sons Co., T. B.

(COUPLINGS, M. P. T., FLUID —see Drives, Fluid)

COUPLINGS, M. P. T., RIGID

Arrowhead Products Div. Federal-Mogul-Bower, Bearings Inc.
Browning Mfg. Co.
Continental Gin Co. Industrial Div.
Cullman Wheel Co.
Dodge Mfg. Corp.
Farrel-Birmingham Co., Inc.
LINK-BELT CO.
Mueller Brass Co.
Philadelphia Gear Corp.
Poole Foundry & Machine Co.
Stratoflex, Inc.
Waldron Corp. John
Weatherhead Co. Fort Wayne Div.
Western Gear Corp.
Wood's Sons Co., T. B.

CRANES, DERRICK BOOM, CRAWLER, LOCOMOTIVE & WHEELED

American Hoist & Derrick Co.
Anthony Co.
AUSTIN-WESTERN CONSTRUCTION EQUIPMENT DIV. BALDWIN-LIMA-HAMILTON CORP.
Baldwin-Lima-Hamilton Corp. Construction Equipment Div.
Bay City Shovels, Inc.
Bucyrus-Erie Co.
Clyde Iron Works, Inc.
Gar Wood Industries, Inc.
HARNISCHFEGER CORP.
Hyster Co.
Industrial Brownhoist Corp.
Insley Manufacturing Corp.
Lakeside Bridge & Steel Co.
Koehring Div. of Koehring Co.
Link-Belt Speeder Corp.
Marion Power Shovel Co.
Maxi Corp.
Northwest Engineering Co.
Ohio Locomotive Crane Co.
Orton Crane & Shovel Co.
Quick-Way Truck Shovel Co.
Schield Bantam Co.
Silent Hoist & Crane Corp.
Thew Shovel Co.
Unit Crane & Shovel Corp.
Locomotive Crane Div., Wellman Engineering Co.

CRANES, DERRICK, STATIONARY (OVER 10-TON)

American Hoist & Derrick Co.
Clyde Iron Works, Inc.
Conco Engineering Works
Insley Manufacturing Corp.
Lakeside Bridge & Steel Co.
Northwest Engineering Co.
Orton Crane & Shovel Co.
Shepard Niles Crane & Hoist Corp.
Unit Crane & Shovel Corp.
Wiley Mfg. Co.

CRANES, JIB (OVER 10-TON)

Clark Equipment Co. Construction Machinery Div.
LE TOURNEAU-WESTINGHOUSE CO.
Manning, Maxwell & Moore, Inc. Shaw Box Crane & Hoist Div.
Orton Crane & Shovel Co.
Shepard Niles Crane & Hoist Corp.
Specialty Engineering Co.
Wellman Engineering Co. McDowell Enterprise
Whiting Corp.

CRANES, JIB & DERRICK (UNDER 10-TON LIFT)

American Chain & Cable Co., Inc. Wright Hoist Div.
American Hoist & Derrick Co.
Anthony Co.
Chisholm-Moore Hoist Div. Columbus McKinnon Chain Corp.
Cleveland Crane & Engrg. Co.
Clyde Iron Works, Inc.
Hack Engineering Co.
Harrington Co.
LE TOURNEAU-WESTINGHOUSE CO.
Louden Machinery Co.
Manning, Maxwell & Moore, Inc. Shaw Box Crane & Hoist Div.
Orton Crane & Shovel Co.
Pitman Mfg. Co.
Reading Crane & Hoist Corp.
Richards-Wilcox Mfg. Co.
Round & Son, Inc., David
Shepard Niles Crane & Hoist Corp.
Silent Hoist & Crane Corp.
Stanco Mfg. & Sales, Inc.
Universal Dredge Mfg. Co.
Wellman Engineering Co. McDowell Enterprise
Westinghouse Air Brake Co.

CRANES, OVERHEAD TRAVELING, GANTRY, BRIDGE, MONORAIL, ETC.

American Chain & Cable Co., Inc. Wright Hoist Div.
American Hoist & Derrick Co.
Chisholm-Moore Hoist Div. Columbus McKinnon Chain Corp.
Cleveland Crane & Engrg. Co.
Clyde Iron Works, Inc.
Conco Engineering Works
Detroit Hoist & Machine Co.
Dravo Corp.
Forker Corp.
Hack Engineering Co.
HARNISCHFEGER CORP.
Harrington Co.
Heyl & Patterson, Inc.
Industrial Brownhoist Corp.
Kaiser Steel Corp., Fabricating Div.
Lakeside Bridge & Steel Co.
Louden Machinery Co.
Manning, Maxwell & Moore, Inc. Shaw Box Crane & Hoist Div.
McKiernan-Terry Corp.
Pacific Coast Engineering Co.
Reading Crane & Hoist Corp.
Richards-Wilcox Mfg. Co.
Robbins & Myers, Inc., Hoist & Crane Div.
Round & Sons, Inc., David
Shepard Niles Crane & Hoist Corp.

Specialty Engineering Co.
STEARNS ROGER MFG. CO.
Universal Dredge Mfg. Co.
Washington Iron Works
Webb Co., Jervis B.
Wellman Engineering Co. McDowell Enterprise
Whiting Corp.
Wiley Mfg. Co.
Yuba Consolidated Industries, Inc., Yuba Mfg. Div.

CRANKSHAFTS, DIESEL ENGINE

Marco Inc.

(CRUSHERS—see below; also see: Mills; Pulverizers)

CRUSHERS, CONE

Acme Road Machinery Co., Inc.
Allis-Chalmers Mfg. Co. Industries Group
Fahrenwald Co., A. W.
Kennedy-Van Saun Mfg. & Eng. Corp.
Lippmann Engineering Works, Inc.
NORDBERG MFG. CO.
Pennsylvania Crusher Div. Bath Iron Works Corp.
Smith Engineering Works

CRUSHERS, DISK

Kennedy-Van Saun Mfg. & Eng. Corp.
NORDBERG MFG. CO.
Sturtevant Mill Co.

CRUSHERS, GYRATORY

Acme Road Machinery Co., Inc.
Allis-Chalmers Mfg. Co. Industries Group
Kennedy-Van Saun Mfg. & Eng. Corp.
MACHINERY CENTER INC.
MINE & SMELTER SUPPLY CO. MARCY MILL DIV.
NORDBERG MFG. CO.
Pennsylvania Crusher Div. Bath Iron Works Corp.
Smith Engineering Works
Straub Mfg. Co.
TRAYLOR ENGINEERING & MFG. CO.

CRUSHERS, HAMMER

Acme Road Machinery Co., Inc.
Allis-Chalmers Mfg. Co. Industries Group
American Pulverizer Co.
Bartlett & Snow Co., C. O.
Buffalo Hammer Mill Corp.
Diamond Iron Works Div. Goodman Mfg. Co.
DIESEL ENERGY CORP.
Gruendler Crusher & Pulverizer Co.
IOWA MFG. CO.
Jeffrey Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Lippmann Engineering Works, Inc.
Metal Carbides Corp.
Metals Disintegrating Co. Inc. Pulverizing Machinery Div.
Pennsylvania Crusher Div. Bath Iron Works Corp.
Pettibone Mulliken Corp.
Rogers Iron Works Co.
Specialty Engineering Co.
Sturtevant Mill Co.
Universal Engineering Corp.
Williams Patent Crusher & Pulverizer Co.

CRUSHERS, IMPACT

Allis-Chalmers Mfg. Co. Industries Group
American Pulverizer Co.
Bartlett & Snow Co., C. O.
Fahrenwald Co., A. W.
Gruendler Crusher & Pulverizer Co.
Hazemag USA Inc.
IOWA MFG. CO.
Jeffrey Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Holmes & Bros., Inc. Robert
Lippmann Engineering Works, Inc.
Mead Mill Co.
NORDBERG MFG. CO.
Pennsylvania Crusher Div. Bath Iron Works Corp.
Pettibone Mulliken Corp.
Pioneer Engineering Div. Poor & Co., Inc.
Pulverizing Machinery Div., Metals Disintegration Co., Inc.
Rogers Iron Works Co.
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
Sturtevant Mill Co.
Universal Engineering Corp.
Williams Patent Crusher & Pulverizer Co.

CRUSHERS, JAW

Acme Road Machinery Co., Inc.
Allis-Chalmers Mfg. Co. Industries Group
Alloy Steel & Metals Co.
Bacon-Green & Milroy
Baldwin-Lima-Hamilton Corp. Construction Equipment Div.
Bico, Inc.
Birdsboro Steel Foundry & Machine Co.
DENVER EQUIPMENT CO.
Denver Fire Clay Co.
Diamond Iron Works Div. Goodman Mfg. Co.
DIESEL ENERGY CORP.
Fahrenwald Co., A. W.
Farrel-Birmingham Co., Inc.
Gruendler Crusher & Pulverizer Co.
IOWA MFG. CO.
Jeffrey Mg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Lippmann Engineering Works, Inc.
McLanahan & Stone Corp.
MINE & SMELTER SUPPLY CO., MFG. DIV.
Morse Bros. Machinery Co.
Pennsylvania Crusher Div. Bath Iron Works Corp.
Pettibone Mulliken Corp.
Pioneer Engineering Div. Poor & Co., Inc.
Rogers Iron Works Co.
Smith Engineering Works
Straub Mfg. Co.
Stroh Process Steel Co.
Sturtevant Mill Co.
TRAYLOR ENGINEERING & MFG. CO.
Universal Engineering Corp.
Universal Road Machinery Co.

CRUSHERS, MOBILE UNITS

Acme Road Machinery Co. Inc.
Baldwin-Lima-Hamilton Corp. Construction Equipment Div.
Bonded Scale & Machine Co.
DENVER EQUIPMENT CO.
Diamond Iron Works Div. Goodman Mfg. Co.
Gruendler Crusher & Pulverizer Co.
Gundlach Machine Co., T. J. Div. of JMJ Industries, Inc.
Hazemag m.b.H.
IOWA MFG. CO.
Kennedy-Van Saun Mfg. & Eng. Corp.
NORDBERG MFG. CO.
Pettibone Mulliken Corp.
Pioneer Engineering Div. Poor & Co., Inc.
Rogers Iron Works Co.
Smith Engineering Works
Straub Mfg. Co.
Universal Engineering Corp.
Universal Road Machinery Co.

CRUSHERS, RING ROLL

Abbé Engineering Co.
American Pulverizer Co.
Gruendler Crusher & Pulverizer Co.
Jeffrey Mfg. Co.
Pennsylvania Crusher Div. Bath Iron Works Corp.
Stephens-Adamson Mfg. Co.
Sturtevant Mill Co.
Williams Patent Crusher & Pulverizer Co.

CRUSHERS, ROLL

Abbé Engineering Co.
Acme Road Machinery Co., Inc.
ALLEN-SHERMAN-HOFF CO.
Allis-Chalmers Mfg. Co. Industries Group
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.
Bartlett & Snow Co., C.O.
Bonded Scale & Machine Co.
Diamond Iron Works Div. Goodman Mfg. Co.
Gruendler Crusher & Pulverizer Co.
Gundlach Machine Co., T. J. Div. of JMJ Industries, Inc.
HEWITT-ROBINS, INC.
IOWA MFG. CO.
Jeffrey Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
LINK-BELT CO.
Lippmann Engineering Works, Inc.
McLanahan & Stone Corp.
McNally Pittsburg Mfg. Corp.
Metal Carbides Corp.
Metals Disintegrating Co. Inc. Pulverizing Machinery Div.
MINE & SMELTER SUPPLY CO., MFG. DIV.
Pennsylvania Crusher Div. Bath Iron Works Corp.
Pettibone Mulliken Corp.
Pioneer Engineering Div. Poor & Co., Inc.
Ridge Equipment Co.
Rogers Iron Works Co.
Smith Engineering Works
Sturtevant Mill Co.
TRAYLOR ENGINEERING & MFG. CO.
Universal Engineering Corp.
Williams Patent Crusher & Pulverizer Co.

CRUSHER PARTS

Abbe' Engineering Co.
Acme Road Machinery Co., Inc.
Alco Products, Inc.
Allis-Chalmers Mfg. Co. Industries Group
Alloy Steel & Metals Co.
American Brake Shoe Co. American Manganese Steel Div.
American Forge Co.
American Pulverizer Co.
BABCOCK & WILCOX CO.
Baldwin-Lima-Hamilton Corp. Construction Equipment Div.
Baldwin-Lima-Hamilton Corp. Standard Steel Works Div.
Bico, Inc.
Bonded Scale & Machine Co.
Electric Steel Foundry Co.
Frog, Switch & Mfg. Co.
Gatke Corp.
Hirsch Bros. Machy. Co.
IOWA MFG. CO.
Jeffrey Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Kensington Steel Div., Poor & Co.
Ladish Co.
Lippmann Engineering Works, Inc.
Metal Carbides Corp.
Pennsylvania Crusher Div. Bath Iron Works Corp.
Pettibone Mulliken Corp.
Pioneer Engineering Div. Poor & Co., Inc.
Rogers Iron Works Co.
Sorel Steel Foundries, Ltd.
Specialty Engineering Co.
Thomas Foundries Inc.
Tool Steel Gear & Pinion Co.
TRAYLOR ENGINEERING & MFG. CO.
Universal Engineering Corp.
Western Gear Corp.
Williams Patent Crusher & Pulverizer Co.

CUTTING MACHINES (ROCK)—does not include Continuous Miners & Planers

American Instrument Co., Inc.
Clipper Mfg. Co.
Goodman Mfg. Co.
Hales Co., W. M.
Herold Mfg. Co.
Joy Mfg. Co.
MOBILE DRILLING, INC.
Salem Tool Co.
Westinghouse Air Brake Co.

CUTTING MACHINE BITS (ROCK)

Allegheny Ludlum Steel Corp.
Cincinnati Mine Mach'y Co.
CRUCIBLE STEEL CO. OF AMERICA
Firth Sterling, Inc.
Hales Co., W. M.
Herold Mfg. Co.
HOFFMAN BROS. DRILLING CO.
KENNAMETAL INC. MINING TOOL DIV.
Marathon Coal Bit Co. Inc.
Metallurgical Products Dept. General Electric Co.
MOBILE DRILLING, INC.
Pickard Industries, Inc. Central Mine Supply Co. Div.
Salem Tool Co.
VASCOLOY-RAMET CORP.
Westinghouse Air Brake Co.

CUTTING MACHINE PARTS (ROCK)

Cincinnati Mine Mach'y Co.
Flood City Brass & Elec. Co.
Joy Mfg. Co.
Mining Machine Parts, Inc.
MOBILE DRILLING, INC.
Penn Machine Co.
Salem Tool Co.
Simonds Worden White Co.
Westinghouse Air Brake Co.

(CYANIDE—see Chemicals)

CYANIDING PROCESS EQUIPMENT (SPECIAL) — does not include standard auxiliary equipment

DENVER EQUIPMENT CO.
MACHINERY CENTER, INC.
National Tank & Pipe Co.

(CYCLONES—see Classifiers, Cyclone)

CYLINDERS, AIR & HYDRAULIC

Anthony Co.
Benton Harbor Engineering Works, Inc.
CARD IRON WORKS, C. S.
Commercial Shearing & Stamping Co.
Erie Strayer Co.
Galland Henning Mfg. Co. Nopak Div.
Kidde & Co., Inc., Walter
Ledeen, Inc.
Minneapolis-Honeywell Regulator Co. Industrial Div.
Moran Engineering Co.
Oilgear Co.
Owatonna Tool Co.
Star Jack Co.
Telluride Iron Works Co.
Vickers Inc.
Anker-Holth Div., Wellman Engineering Co.
Westinghouse Air Brake Co. Ind. Products Div.

D

(DENSITY METERS—see Meters, Liquid & Slurry, Density)

DIAMONDS, INDUSTRIAL

American Coldset Corp.
Diamond Drill Carbon Co.
Diamond Products, Inc.
DIAMOND TOOL RESEARCH CO., INC.
HOFFMAN BROS. DRILLING CO.
Koebel Diamond Tool Co.
Metal Carbides Corp.
SMIT & CO., ANTON
Smit & Sons, Inc., J. K.
SPRAGUE & HENWOOD, INC.
Varel Mfg. Co.
Willey's Carbide Tool Co.

DIAMOND CONCENTRATING EQUIPMENT (SPECIAL)—does not include standard auxiliary equipment

DENVER EQUIPMENT CO.
HOFFMAN BROS. DRILLING CO.

(DIPPER SHOVELS—see Excavators)

(DOCKS — see Contractors, Construction, Piers & Wharves

(DOORS, MINE — see Mine Doors)

DRAFTING EQUIPMENT & SUPPLIES — also see Blu, Photo & White Print Machines

Berger & Sons, C. L., Inc.
Black Diamond Spad Co.
Bruning Co., Inc. Charles
Dixon Crucible Co., Joseph
Go-Optic Co., Inc.
Gerber Scientific Instrument Co.
KERN INSTRUMENTS, INC.
Keuffel & Esser Co.
Ozalid Div., General Aniline & Film Corp.
Pease Co. C. F.
Post Co., Frederick
Suverkrop Instruments
Warren-Knight Co.

(DRAGLINES — see Excavators)
***DRILLS (ROCK & EARTH), (DREDGES — see below; also**

(DRAGLINESCRAPER-SLUSHERS—see: Buckets; Hoists; Excavators, Dragline Tower)

(DREDGES, FLOATING — see below; also see: Buckets; Hoists; Excavators)

DREDGES, BUCKETLINE

Dravo Corp.
Ellicott Machine Corp.
Washington Iron Works
Yuba Consolidated Industries, Inc., Yuba Mining Div.

DREDGES, DIPPER SHOVEL

Dravo Corp.
Elcott Machine Corp.
Sorel Steel Foundries, Ltd.

DREDGES, DRAGLINE & GRAB CRANE

American Hoist & Derrick Co.
Bodinson Manufacturing Co., Inc.
Dravo Corp.
Elliott Machine Corp.
Hyster Co.

DREDGES SUCTION

American Brake Shoe Co. American Manganese Steel Div.
American Hoist & Derrick Co.
Eagle Iron Works
Ellicott Machine Corp.
Erie Pump & Engine Works
Essick Manufacturing Co.
Hack Engineering Co.
Mekum Engineering, Inc.
MORRIS MACHINE WORKS
Pacific Coast Engineering Co.
Universal Dredge Mfg. Co.
Yuba Consolidated Industries, Inc., Yuba Mining Div.

DREDGE HULLS — also see Barges

American Hoist & Derrick Co.
Bodinson Manufacturing Co., Inc.
Dravo Corp.
Ellicott Machine Corp.
Meckum Engineering, Inc.
Pacific Coast Engineering Co.
Wiley Mfg. Co.
Yuba Consolidated Industries, Inc., Yuba Mining Div.

DREDGE SLEEVES

Ellicott Machine Corp.
Goodrich Industrial Products Co., b. f.
HEWITT-ROBINS, INC.
New York Belting & Packing Co.
Faybestos-Manhattan, Inc. Manhattan Rubber Div.
Republic Rubber Div. Lee Rubber & Tire Corp.

(DRILLS, HAND, PORTABLE ELECTRIC — see Tools, Hand, Power)

DRILLS (ROCK & EARTH), AUGER (SURFACE RIG)

Acker Drill Co.
Cardox Corp. Hardsocg Div.
Chicago Pneumatic Tool Co.
GARDNER-DENVER CO.
HOFFMAN BROS. DRILLING CO.
Holman Bros.—Canada Ltd.
INGERSOLL-RAND CO.
Leetonia Tool Co.
Mayhew Machine & Supply Co.
Metallurgical Products Dept. General Electric Co.
MOBILE DRILLING, INC.
Pennsylvania Drilling Co.
Pickard Industries, Inc. Central Mine Supply Co., Div.
REICH BROS. MFG. CO., INC.
Salem Tool Co.
Schroeder Brothers Corp.
STARDRILL-KEYSTONE CO.
Thor Power Tool Co.
Worthington Corp.

DRILLS (ROCK), CHURN

Bucyrus-Erie Co.
GARDNER-DENVER CO.
HOFFMAN BROS. DRILLING CO.
Hossfeld Mfg. Co.
MOBILE DRILLING, INC.
National Welding & Mfg. Co.
Sanderson Cyclone Drill Co.
Spang & Co.
STARDRILL-KEYSTONE CO.

DRILLS (ROCK), DIAMOND

Acker Drill Co.
BOYLES BROS. DRILLING CO., LTD. (VANCOUVER)
Chicago Pneumatic Tool Co.
Diamond Drill Carbon Co.
DIAMOND DRILL CONTRACTING CO.
Diamond Products, Inc.
DIAMOND TOOL RESEARCH CO., INC.
Drilling Accessory & Mfg. Co., Inc.
Failing Co., George E.
Havlick, J. L.
HOFFMAN BROS. DRILLING CO.
Joy Mfg. Co.
Koebel Diamond Tool Co.
Longyear Co., E. J.
Mayhew Machine & Supply Co.
McClintock Co., R. S.
Metal Carbides Corp.
MOBILE DRILLING, INC.
Mott Cor Drilling Co.
Packsack Diamond Drills, Ltd.
Pennsylvania Drilling Co.
REICH BROS. MFG. CO., INC.
SPRAGUE & HENWOOD, INC.
STARDRILL-KEYSTONE CO.
Wheel Trueing Tool Co.

DRILLS (ROCK), FLAME-JET PIERCING

Bucyrus-Erie Co.
Linde Co. Union Carbide Corp.

DRILLS (ROCK & EARTH), WATER-JET—does not include Monitors

CARPCO MANUFACTURING, INC.

DRILLS (ROCK), PERCUSSION, LARGE HOLE (+4-IN.), QUARRY & WELL

Acme Machinery Co.
Bucyrus-Erie Co.
Cardox Corp., Hardsocg Div.
GARDNER-DENVER CO.
HOFFMAN BROS. DRILLING CO.
INGERSOL-RAND CO.
Joy Mfg. Co.
Mayhew Machine & Supply Co.
Metal Carbides Corp.
MOBILE DRILLING, INC.
REICH BROS. MFG. CO., INC.
Sanderson Cyclone Drill Co.
STARDRILL-KEYSTONE CO.
Le Roi Div. Westinghouse Air Brake Co.
Worthington Corp.

DRILLS (ROCK), PERCUSSION, LARGE HOLE (+4-IN.), QUARRY & WELL, "DOWN-THE-HOLE" TYPE ONLY

GARDNER-DENVER CO.
INGERSOL-RAND CO.
REICH BROS. MFG. CO., INC.
WINTER WEISS CO.

DRILLS (ROCK), PERCUSSION, SMALL HOLE (—4-IN.)

Acme Machinery Co.
Atlas Copco Eastern, Inc.
Atlas Copco Pacific, Inc.
Bucyrus-Erie Co.
Chicago Pneumatic Tool Co.
GARDNER-DENVER CO.
HOFFMAN BROS. DRILLING CO.
Holman Bros.—Canada Ltd.
Hossfeld Mfg. Co.
INGERSOLL-RAND CO.
Joy Mfg. Co.
Le Roi Div. Westinghouse Air Brake Co.
Metal Carbides Corp.
MOBILE DRILLING, INC.
REICH BROS. MFG. CO., INC.
Salem Tool Co.
Sanderson Cyclone Drill Co.
Schramm, Inc.
STARDRILL-KEYSTONE CO.
Thor Power Tool Co.
Westinghouse Air Brake Co.
Worthington Corp.

DRILLS (ROCK), ROTARY, LARGE HOLE (+4-IN.), QUARRY & WELL

Acker Drill Co.
BOYLES BROS. DRILLING CO., LTD. (VANCOUVER)
Bucyrus-Erie Co.
Chicago Pneumatic Tool Co.
Davey Compressor Co.
Drilling Accessory & Mfg. Co., Inc.
Failing Co., George E.
GARDNER-DENVER CO.
HOFFMAN BROS. DRILLING CO.
Industrial Overlay Metals, Inc.
INGERSOLL-RAND CO.
Joy Mfg. Co.
Maschinenfabrik Rudolf Hausherr & Soehne, GmbH c/o B. J. Nykerk Corp.
Mayhew Machine & Supply Co.
Metal Carbides Corp.
MOBILE DRILLING, INC.
REICH BROS. MFG. CO., INC.
Salem Tool Co.
Schramm, Inc.
STARDRILL-KEYSTONE CO.
Westinghouse Air Brake Co.
WINTER WEISS CO.
Worthington Corp.

DRILLS (ROCK), ROTARY, SMALL HOLE (—4-IN.)

Acker Drill Co.
Allegheny Ludlum Steel Corp.
BOYLES BROS. DRILLING CO., LTD. (VANCOUVER)
Bucyrus-Erie Co.
Davey Compressor Co.
DIAMOND DRILL CONTRACTING CO.
Diamond Products, Inc.
Drilling Accessory & Mfg. Co., Inc.
Fletcher & Co., J. H.
GARDNER-DENVER CO.
HOFFMAN BROS. DRILLING CO.
Industrial Overlay Metals, Inc.
INGERSOLL-RAND CO.
Joy Mfg. Co.
Long Co.
Maschinenfabrik Rudolf Hausherr & Soehne GmbH c/o B. J. Nykerk Corp.
Mayhew Machine & Supply Co.
Metal Carbides Corp.
MOBILE DRILLING, INC.
Pennsylvania Drilling Co.
REICH BROS. MFG. CO., INC.
Salem Tool Co.
Schramm, Inc.
Seismograph Service Corp.
Star Expansion
STARDRILL-KEYSTONE CO.
Westinghouse Air Brake Co.
WINTER WEISS CO.
Worthington Corp.

DRILLS (ROCK), ROTARY-PERCUSSION, SMALL HOLE (—4-IN.)

Maschinenfabrik Rudolf Hausherr & Soehne, GmbH c/o B. J. Nykerk Corp.
MOBILE DRILLING, INC.
Salem Tool Co.

DRILLS (ROCK), SELF-CONTAINED POWER, PACK-PORTABLE, PERCUSSION

Atlas Copco Pacific, Inc.
Hossfeld Mfg. Co.
Lovequist Engrg. Co.
Pitnam Industrial Products Co.
Stanco Mfg. & Sales Co.
Syntron Co.
Warsop Power Tools Ltd.

DRILLS (ROCK), SELF-CONTAINED POWER, PACK-PORTABLE, ROTARY (& CORE)

DIAMOND DRILL CONTRACTING CO.
Demo Tool Corp.
Havlick, J. L.
Homelite Div., Textron Inc.
Houston Tool Co.
Packsack Diamond Drills, Ltd.

DRILLS, BORERS & CORERS SPECIAL LARGE DIAMETER RIGS (+12 in.) —also see Continuous Miners; does not include Cutting Machines or other drills listed above

REICH BROS MFG. CO., INC.

DRILL (ROCK) BITS, AUGER

Acker Drill Co.
Cardox Corp. Hardsocg Div.
Central Mine Equipment Co.
Chicago Pneumatic Tool Co.
DIAMOND DRILL CONTRACTING CO.
GARDNER-DENVER CO.
HAWTHORNE, INC., HERB J.
HOFFMAN BROS. DRILLING CO.
INGERSOLL-RAND CO.
KENNAMETAL INC. MINING TOOL DIV.
Mayhee Machine & Supply Co.
Metal Carbides Corp.
Metallurgical Products Dept. General Electric Co.
MOBILE DRILLING, INC.
National Mine Service Co.
Pennsylvania Drilling Co.
REICH BROS. MFG. CO., INC.
Salem Tool Co.
Schroeder Brothers Corp.
STARDRILL-KEYSTONE CO.
VASCOLOY-RAMET CORP.
Worthington Corp.

DRILL (ROCK) BITS (& STEMS), CHURN

Buycrus-Eire Co.
MOBILE DRILLING, INC.
Sanderson Cyclone Drill Co.
Spang & Co.
STARDRILL-KEYSTONE CO.
Worthington Corp.

DRILL (ROCK) BITS, CORE

Acker Drill Co.
American Coldset Corp.
BOYLES BROS. DRILLING CO., LTD. (VANCOUVER)
CHRISTENSEN DIAMOND PRODUCTS CO.
Davey Compressor Co.
Diamond Drill Carbon Co.
DIAMOND DRILL CONTRACTING CO.
Drilling Accessory & Mfg. Co., Inc.
Diamond Products, Inc.
GARDNER-DENVER CO.
HOFFMAN BROS. DRILLING CO.
Joy Mfg. Co.
KENNAMETAL INC. MINING TOOL DIV.
Longyear Co., E. J.
Mayhew Machine & Supply Co.
McClintock Co., R. S.
Metal Carbides Corp.
MOBILE DRILLING, INC.
Mott Core Drilling Co.
Pennsylvania Drilling Co.
Reed Roller Bit Co.
Salem Tool Co.
SPRAGUE & HENWOOD, INC.
Star Expansion
STARDRILL-KEYSTONE CO.
Varel Mfg. Co.
Westinghouse Air Brake Co.
Worthington Corp.

DRILL (ROCK) BITS, DIAMOND

Acker Drill Co.
American Coldset Corp.
BOYLES BROS. DRILLING CO., LTD. (VANCOUVER)
Chicago Pneumatic Tool Co.
CHRISTENSEN DIAMOND PRODUCTS CO.
Davey Compressor Co.
Diamond Drill Carbon Co.
DIAMOND DRILL CONTRACTING CO.
Diamond Products, Inc.
DIAMOND TOOL RESEARCH CO., INC.
Drilling Accessory & Mfg. Co., Inc.
Havlick, J. L.
HOFFMAN BROS. DRILLING CO.
Joy Mfg. Co.
Koebel Diamond Tool Co.
Longyear Co., E. J.
Mayhew Machine & Supply Co.

McClintock Co., R. S.
Metal Carbides Corp.
MOBILE DRILLING, INC.
Mott Core Drilling Co.
Packsack Diamond Drills, Ltd.
Pennsylvania Drilling Co.
Salem Tool Co.
SMIT & CO., ANTON
Smit & Sons, Inc., J. K.
SPRAGUE & HENWOOD, INC.
STARDRILL-KEYSTONE CO.
Varel Mfg. Co.
Wheel Trueing Co.

DRILL (ROCK) BITS, DIAMOND, RESETTING SERVICE

Acker Drill Co.
American Coldset Corp.
BOYLES BROS. DRILLING CO., LTD. (VANCOUVER)
CHRISTENSEN DIAMOND PRODUCTS CO.
Diamond Drill Carbon Co.
DIAMOND DRILL CONTRACTING CO.
Diamond Products, Inc.
DIAMOND TOOL RESEARCH CO., INC.
Drilling Accessory & Mfg. Co., Inc.
Havlick, J. L.
HOFFMAN BROS. DRILLING CO.
Joy Mfg. Co.
Koebel Diamond Tool Co.
Longyear Co., E. J.
Mayhew Machine & Supply Co.
McClintock Co., R. S.
Metal Carbides Corp.
Pennsylvania Drilling Co.
SPRAGUE & HENWOOD, INC.
Varel Mfg. Co.
Wheel Trueing Co.

DRILL (ROCK) BITS, PERCUSSION

Acme Machinery Co.
Atlas Copco Eastern, Inc.
Atlas Copco Pacific, Inc.
BRUNNER & LAY ROCK BIT OF PHILADELIPHA, INC.
Bucyrus-Erie Co.
Firth Sterling Inc.
Hayes Steel Products Ltd.
Holman Bros.—Canada Ltd.
INGERSOLL-RAND CO.
Joy Mfg. Co.
KENNAMTEAL INC. MINING TOOL DIV.
Le Roi Div. Westinghouse Air Brake Co.
Mayhew Machine & Supply Co.
Metal Carbides Corp.
Minerals Engineering Co.
MOBILE DRILLING, INC.
REICH BROS. MFG. CO., INC.
Sanderson, Cyclon Drill Co.
Star Expansion
STARDRILL-KEYSTONE CO.
Thor Power Tool Co.
Throwaway Bit Corp.
Timken Roller Bearing Co.
VASCOLOY-RAMET CORP.
WESTERN ROCK BIT MFG. CO.
Westinghouse Air Brake Co.

DRILL (ROCK) BITS, ROTARY, ROLLER CONE

Acker Drill Co.
Central Mine Equipment Co.
Chicago Pneumatic Tool Co.
Davey Compressor Co.
Drilling Accessory & Mfg. Co., Inc.
HAWTHORNE, INC., HERB J.
HOFFMAN BROS. DRILLING CO.
Hughes Tool Co.
Industrial Overlay Metals, Inc.
Longyear Co., E. J.
Mayhew Machine & Supply Co.
MOBILE DRILLING, INC.
Pennsylvania Drilling Co.
Reed Roller Bit Co.
REICH BROS. MFG. CO., INC.
SPRAGUE & HENWOOD. INC.
Star Expansion
STARDRILL-KEYSTONE CO.
Varel Mfg. Co.
Westinghouse Air Brake Co.

DRILL (ROCK) BITS, ROTARY DRAG; LARGE HOLE (+4-IN.), QUARRY & WELL (SPADE, PRONG, ETC.)

Acker Drill Co.
Cardox Corp. Hardscog Div.
Davey Compressor Co.
GARDNER-DENVER CO.
HAWTHORNE, INC., HERB J.
HOFFMAN BROS. DRILLING CO.
Industrial Overlay Metals, Inc.
KENNAMETAL INC. MINING TOOL DIV.
Maschinenfabrik Rudolf Hausherr & Soehne, GmbH c/o B. J. Nykerk Corp.
Mayhew Machine & Supply Co.
MOBILE DRILLING, INC.
REICH BROS MFG. CO., INC.
Reed Roller Bit Co.
Salem Tool Co.
STARDRILL-KEYSTONE CO.
Varel Mfg. Co.
Westinghouse Air Brake Co.

DRILL (ROCK) BITS, ROTARY, DRAG, SMALL HOLE (—4-IN.) (SPADE, PRONG, ETC.)

Acker Drill Co.
Allegheny Ludlum Steel Corp.
Davey Compressor Co.
Drilling Accessory & Mfg. Co., Inc.
Firth Sterling Inc.
GARDNER-DENVER CO.
HAWTHORNE, INC., HERB J.
HOFFMAN BROS. DRILLING CO.
Industrial Overlay Metals, Inc.
KENNAMETAL INC. MINING TOOL DIV.
Maschinenfabrik Rudolf Hausherr Soehne, GmbH c/o B. J. Nykerk Corp.
Mayhew Machine & Supply Co.
MOBILE DRILLING, INC.
Pennsylvania Drilling Co.
Reed Roller Bit Co.
REICH BROS. MFG. CO., INC.
STARDRILL-KEYSTONE CO.
Thor Power Tool Co.
Varel Mfg. Co.
VASCOLOY-RAMET CORP.
Westinghouse Air Brake Co.

DRILL (ROCK) BIT & STEEL FORGING & HEAT TREATING FURNACES

Acme Machinery Co.
Bucyrus-Erie Co.
GARDNER-DENVER CO.
HOFFMAN BROS. DRILLING CO.
INGERSOLL-RAND CO.
MOBILE DRILLING, INC.
Sanderson Cyclone Drill Co.
STARDRILL-KEYSTONE CO.

DRILL (ROCK) BIT & STEEL FORGING HAMMERS

GARDNER-DENVER CO.
INGERSOLL-RAND CO.

DRILL (ROCK) BIT & STEEL GRINDERS

Atlas Copco Eastern, Inc.
Atlas Copco Pacific, Inc.
Bitco, Inc.
Blount Co., J. G.
BRUNNER & LAY ROCK BIT OF PHILADELPHIA, INC.
Coeur d'Alene Hardware & Foundry Co.
GARDNER-DENVER CO.
Herold Mfg. Co.
Holman Bros.—Canada Ltd.
INGERSOLL-RAND CO.
Joy Mfg. Co.
MINE & SMELTER SUPPLY CO., MFG. DIV.
REICH BROS. MFG. CO., INC.
WESTERN ROCK BIT MFG. CO.

DRILL (ROCK) BIT & STEEL LATHES

INGERSOLL-RAND CO.

DRILL (ROCK) BOOMS, EXTENSIBLE & MOTILE — also see: Booms & Towers; Drill (Rock) Jumbos

Chicago Pneumatic Tool Co.
INGERSOLL-RAND CO.
Joy Mfg. Co.
Rogers Iron Works Co.

DRILL (ROCK) CORE BARRELS

Acker Drill Co.
American Coldset Corp.
BOYLES BROS. DRILLING CO., LTD. (VANCOUVER)
CHRISTENSEN DIAMOND PRODUCTS CO.
Davey Compressor Co.
DIAMOND DRILL CONTRACTING CO.
Drilling Accessory & Mfg. Co., Inc.
Failing Co., George E.
GARDNER-DENVER CO.
HOFFMAN BROS. DRILLING CO.
Joy Mfg. Co.
Longyear Co., E. J.
Mayhew Machine & Supply Co.
Minerals Engineering Co.
MOBILE DRILLING INC.
Mott Core & Drilling Co.
Pennsylvania Drilling Co.
Reed Roller Bit Co.
REICH BROS. MFG. CO., INC.
SPRAGUE & HENWOOD, INC.
STARDRILL-KEYSTONE CO.

DRILL (ROCK) DUST COLLECTORS (SMALL HOLE DRILLS)

Acme Machinery Co.
Davey Compressor Co.
Drilling Accessory & Mfg. Co., Inc.
DUCON INC.,
Failing Co., George E.
Hayes Steel Products, Ltd.
Holman Bros.—Canada Ltd.
INGERSOLL-RAND CO.
Fletcher & Co., J. H.
Le Roi Div. Westinghouse Air Brake Co.
Markley Dust Control System, Inc.
REICH BROS. MFG. CO., INC.
Spencer Turbine Co.
Thor Power Tool Co.
Westinghouse Air Brake Co.

DRILL (ROCK) DUST COLLECTORS (QUARRY DRILLS)

Davey Compressor Co.
DUCON, INC.
INGERSOLL-RAND CO.
Markley Dust Control System, Inc.
Mayhew Machine & Supply Co.
REICH BROS. MFG. CO., INC.
Spencer Turbine Co.

DRILL (ROCK) JUMBOS & WAGONS—also see: Booms & Towers; Drill (Rock) Booms

Acme Machinery Co.
Chicago Pneumatic Tool Co.
Coeur d'Alene Hardware & Foundry Co.
GARDNER-DENVER CO.
Hayes Steel Products, Ltd.
INGERSOLL-RAND CO.
Joy Mfg. Co.
Le Roi Div. Westinghouse Air Brake Co.
MACHINERY CENTER, INC.
Maschinenfabrik Rudolf Hausherr & Soehne, GmbH c/o B. J. Nykerk Corp.
MAYO TUNNEL & MINE EQUIPMENT
Minerals Engineering Co.
REICH BROS. MFG. CO., INC.
Rogers Iron Works Co.
Sanford-Day Iron Works, Inc.
Schramm, Inc.
Thor Power Tool Co.
Westinghouse Air Brake Co.
WINTER WEISS CO.
Worthington Corp.

(DRILL (ROCK) RODS, CHURN—see Drill (Rock) Bits (& Stems), Churn)

DRILL (ROCK) RODS, DIAMOND

Acker Drill Co.
Bethlehem Pacific Coast Steel Corp.
BOYLES BROS. DRILLING CO., LTD. (VANCOUVER)
Brunner & Lay Rock Bit of Philadelphia, Inc.
CHRISTENSEN DIAMOND PRODUCTS CO.
CRUCIBLE STEEL CO. OF AMERICA
Diamond Drill Carbon Co.
DIAMOND DRILL CONTRACTING CO.
HOFFMAN BROS. DRILLING CO.
Hoyland Steel Co., Inc.
Joy Mfg. Co.
Koebel Diamond Tool Co.
Longyear Co., E. J.
Mayhew Machine & Supply Co.
Minerals Engineering Co.
MOBILE DRILLING, INC.
Mott Core Drilling Co.
Pennsylvania Drilling Co.
SPRAGUE & HENWOOD, INC.

DRILL (ROCK) RODS, PERCUSSION

Amce Machinery Co.
Atlas Copco Eastern, Inc.
Atlas Steels, Ltd.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co.
Bitco. Inc.
Black's Machine Shop
BRUNNER & LAY ROCK BIT OF PHILADELPHIA, INC.
Coeur d'Alene Hardware & Foundry Co.
CRUCIBLE STEEL CO. OF AMERICA
GARDNER-DENVER CO.
Hoyland Steel Co., Inc.
INGERSOLL-RAND CO.
Joy Mfg. Co.
Marathon Coal Bit Co. Inc.
Minerals Engineering Co.
MOBILE DRILLING, INC.
Sanderson Cyclone Drill Co.
STARDRILL-KEYSTONE CO.
Thor Power Tool Co.
Westinghouse Air Brake Co.

DRILL (ROCK) RODS, ROTARY LARGE HOLE (QUARRY & WELL)

Acker Drill Co.
BOYLES BROS. DRILLING CO., LTD. (VANCOUVER)
CRUCIBLE STEEL CO. OF AMERICA
Davey Compressor Co.
Drilling Accessory & Mfg. Co., Inc.
Failing Co., George E.
GARDNER-DENVER CO.
HOFFMAN BROS. DRILLING CO.
Hoyland Steel Co., Inc.
INGERSOLL-RAND CO.
Joy Mfg. Co.
Marathon Coal Bit Co. Inc.
Maschinenfabrik Rudolf Hausherr & Soehne, GmbH c/o B. J. Nykerk Corp.
Mayhew Machine & Supply Co.
MOBILE DRILLING, INC.
REICH BROS. MFG. CO., INC.
Sanderson Cyclone Drill Co.
Schramm, Inc.
STARDRILL-KEYSTONE CO.
WINTER WEISS CO.

DRILL (ROCK) RODS, ROTARY SMALL HOLE

Acker Drill Co.
Atlas Copco Pacific, Inc.
Bethlehem Pacific Coast Steel Corp.
BOYLES BROS. DRILLING CO., LTD (VANCOUVER)
CRUCIBLE STEEL CO. OF AMERICA
Davey Compressor Co.
DIAMOND DRILL CONTRACTING CO.
Drilling Accessory & Mfg. Co., Inc.
GARDNER-DENVER CO.
Guyan Machinery Co.
HOFFMAN BROS. DRILLING CO.
Hoyland Steel Co., Inc.
INGERSOLL-RAND CO.
Joy Mfg. Co.
Marathon Coal Bit Co. Inc.
Maschinenfabrik Rudolf Hausherr & Soehne, GmbH c/o B. J. Nykerk Corp.
Mayhew Machine & Supply Co.
MOBILE DRILLING, INC.
Pennsylvania Drilling Co.
REICH BROS MFG. CO., INC.
Sanderson Cyclone Drill Co.
Schramm, Inc.
STARDRILL-KEYSTONE CO.
Thor Power Tool Co.
Varel Mfg. Co.
Westinghouse Air Brake Co.
WINTER WEISS CO.

DRILL (ROCK) ROD COUPLINGS

Acme Machinery Co.
Atlas Copco Eastern, Inc.
Atlas Copco Pacific, Inc.
Bitco, Inc.
BOYLES BROS. DRILLING CO., LTD. (VANCOUVER)
BRUNNER & LAY ROCK BIT OF PHILADELPHIA, INC.
CRUCIBLE STEEL CO. OF AMERICA
DIAMOND DRILL CONTRACTING CO.
GARDNER-DENVER CO.
INGERSOLL-RAND CO.
Joy Mfg. Co.
Maschinenfabrik Rudolf Hausherr & Soehne, GmbH c/o B. J. Nykerk Corp.
Minerals Engineering Co.
MOBILE DRILLING, INC.
REICH BROS MFG. CO., INC.
Thor Power Tool Co.
WINTER WEISS CO.

(DRILL STEEL — see Drill (Rock) Rods)

DRILL (ROCK) SUPPORTS (COLUMNS, BARS, ETC.) —also see Drill (Rock) Jumbos; Drill (Rock) Booms

Chicago Pneumatic Tool Co.
GARDNER DENVER CO.
Hayes Steel Products, Ltd.
INGERSOLL-RAND CO.
Joy Mfg. Co.
Le Roi Div. Westinghouse Air Brake Co.
Minerals Engineering Co.
Thor Power Tool Co.
Westinghouse Air Brake Co.

(DRIVES, MECHANICAL POWER TRANSMISSION —see below; also see: Clutches; Couplings, Power Take-Offs; Gear Motors)

DRIVES, BELT

Allis-Chalmers Mfg. Co. Industries Group
American Pulley Co.
American Rubber Mfg. Co.
Browning Mfg. Co.
Christian Engineers, J. D.
Continental Gin Co. Industrial Div.
Dodge Mfg. Corp.
Flexible Steel Lacing Co.
Gates Rubber Co.
Graton & Knight Co. Inc.
HEWITT-ROBINS, INC.
Hirsch Bros. Machy. Co.
Houghton & Co., E. F.
Kanawha Mfg. Co.
LINK-BELT CO.
McNally Pittsburg Mfg. Corp.
Morse Chain Co.
NATIONAL IRON CO.
New York Belting & Packing Co.
Quaker Rubber Div. H. K. Porter Co., Inc.
Wood's Sons Co., T. B.
U. S. Rubber Co. Mechanical Goods Div.

DRIVES, CHAIN

Bartlett & Snow Co., C. O.
Browning Mfg. Co.
Chain Belt Co.
Christian Engineers, J. D.
Continental Gin Co. Industrial Div.
Dodge Mfg. Corp.
Hirsch Bros. Machy. Co.
Jeffrey Mfg. Co.
LINK-BELT CO.
McNally Pittsburg Mfg. Corp.
Morse Chain Co. A Borge-Warner Industry
NATIONAL IRON CO.
Ohio Gear Co.
Union Chain & Mfg. Co.
Voland & Sons, Inc.
Webb Co., Jervis B.
Whitney Chain Co.

DRIVES, FLUID

American Blower Div. American-Standard
Christian Engineers, J. D.
Clark Equipment Co. Transmission Div.
Dodge Mfg. Corp.
General Motors Corp. Allison Div.
LINK-BELT CO.
Master Electric Co.
Oilgear Co.
Prime Mover Co.
Schroeder Brothers Corp.
Titeflex, Inc.
Twin Disc Clutch Co.
Vickers Inc.
Western Gear Corp.

DRIVES, GEAR

Allis Co., Louis
American Pulley Co.
Bartlett & Snow Co., C. O.
Brown, Inc., David
Christian Engineers, J. D.
Cleveland Worm & Gear Co.
Cone-Drive Gears Div. Michigan Tool Co.
Continental Gin Co. Industrial Div.
DeLaval Steam Turbine Co.
FALK CORP.
Farrel-Birmingham Co., Inc.
Foote Bros. Gear & Machine Corp.
General Electric Co. Gear Motor & Transmission Components Dept.
General Motors Corp. Allison Div.
HEWITT-ROBINS, INC.
Hirsch Bros. Machy. Co.
Kanawha Mfg. Co.
Lima Electric Motor Co.
LINK-BELT CO.
Master Electric Co.
McNally Pittsburg Mfg. Corp.
NATIONAL IRON CO.
Ohio Gear Co.
Perkins Machine & Gear Co.
Philadelphia, Gear Corp.
Rockwell Spring & Axle Co. Timken-Detroit Axle Div.
Snow-Nabstedt Gear Corp.
Sterling Electric Motors, Inc.
Stimmel Winch Co., Inc.
Tool Steel Gear & Pinion Co.
Twin Disc Clutch Co.
U. S. Electrical Motors, Inc.
Universal Gear Div., Novo Pump & Engine Co.
Western Gear Corp.
Yuba Consolidated Industries, Inc., Yuba Mfg. Div.

DRIVES, GEAR, SHAFT-MOUNTED

Allis Co., Louis
American Pulley Co.
Christian Engineers, J. D.
Cone-Drive Gears Div. Michigan Tool Co.
Continental Gin Co. Industrial Div.
Dodge Mfg. Corp.
FALK CORP.
Foote Bros. Gear & Machine Corp.
HEWITT-ROBINS, INC.
Hirsch Bros. Machy. Co.
Kanawha Mfg. Co.
LINK-BELT CO.
Lovejoy Flexible Coupling Co.
Master Electric Co.
Morse Chain Co.
NATIONAL IRON CO.
Perkins Machine & Gear Co.
Philadelphia Gear Corp.
Rockwell Spring & Axle Co. Timken-Detroit Axle Div.
Tool Steel Gear & Pinion Co.
Universal Gear Div., Novo Pump & Engine Co.
Western Gear Corp.
Yuba Consolidated Industries, Inc., Yuba Mfg. Div.

DRIVES, MAGNETIC & EDDY-CURRENT

Allis Co., Louis
Cone-Drive Gears Div., Michigan Tool Co.
Cutler-Hammer, Inc.
Dings Magnetic Separator Co.
Eaton Mfg. Co.
Electric Machinery Mfg. Co.
Fawick Airflex Co., Inc.
Whitney Chain Co.

DRIVES, VARIABLE SPEED

Allis Co., Louis
Allis-Chalmers Mfg. Co. Industries Group
American Blower Div. American-Standard
American Pulley Co.
Browning Mfg Co.
Clark Controller Co.
Clark Equipment Co. Transmission Div.
Cleveland Worm & Gear Co.
Cone-Drive Gears Div., Michigan Tool Co.
Cutler-Hammer, Inc.
Dodge Mfg. Corp.
Eaton Mfg. Co.
Electro Dynamic Div. General Dynamics Corp.
Foote Bros. Gear & Machine Corp.
Fuller Manufacturing Co.
General Electric Co. Apparatus Sales Div.
General Electric Co. Gear Motor & Transmission Components Dept.
General Motors Corp. Allison Div.
HEWITT-ROBINS, INC.
Lewellen Mfg. Co.
Lima Electric Motor Co.
LINK-BELT CO.
Lovejoy Flexible Coupling Co.
Master Electric Co.
Morse Chain Co.
NATIONAL SUPPLY CO.
Oilgear Co.
Philadelphia Gear Corp.
Reeves Pulley Co., Div. Reliance Electric & Engineering Co.
Reliance Electric & Engineering Co.
Rockwell Spring & Axle Co. Timken-Detroit Axle Div.
Sterling Electric Motors, Inc.
U. S. Electrical Motors, Inc.
Vickers Inc.
Webb Co., Jervis B.
Western Gear Corp.
Wood's Sons Co., T. B.
Worthington Corp.

(DRYERS — see below; also see: Classifiers; Filters; Heaters; Kilns; Screens, Electrically Heated)

DRYERS, HEATED DRUM

Allis-Chalmers Mfg. Co. Industries Group
Bartlett & Snow Co., C. O.
Bruning Co., Inc. Charles
Canadian Locomotive Co., Ltd.
Davis Foundry & Machine Works
DENVER EQUIPMENT CO.
General American Transportation Corp. Louisville Dryer Div.
GOULD CO., GORDON I.
Hack Engineering Co.
HARDINGE CO., INC.
Hazemag USA Inc.
Hevi-Duty Electric Co.
Hirsch Bros. Machy. Co.
Holmes & Bros., Inc. Robert
IOWA MFG. CO.
Jeffrey Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
LINK-BELT CO.
MINE & SMELTER SUPPLY CO., MFG. DIV.
NORDBERG MFG. CO.
Rockwell Co. W. S.
Simplicity System Co.
Southwestern Engineering Co.
Standard Steel Corp.
STEARNS ROGER MFG. CO.
TRAYLOR ENGINEERING & MFG. CO.
Universal Dredge Mfg. Co.
Washington Machinery Co.

DRYERS, INFRA-RED

Booth Co.
Corning Glass Works
Fisher Scientific Co.
HEWITT-ROBINS, INC.
Jeffrey Mfg. Co.

DRYERS, VIBRATING PAN, ELECTRICALLY HEATED

Carrier Conveyor Corp.
Jeffrey Mfg. Co.
LINK-BELT CO.
Syntron Co.

DUST COLLECTORS & PRECIPITATORS—does not include: Classifiers, Cyclone, Dry; Drill (rock) Dust Collectors; Filters. Air; Scrubbers, Air & Waste Gas

American Air Filter Co., Inc.
American Blower Div. American-Standard
BUELL ENGINEERING CO.
Cincinnati Electrical Tool Co.
Convair, Inc.
DIESEL ENERGY CORP.
DUCON, INC.
Dustex Corp.
Fluor Products Co., Hartmann Div.
Fly Ash Arrestor Corp.
Fuller Co.
Hagan Chemicals & Controls, Inc. Divisions: Calgon Co., Hall Laboratories
Hisey-Wolf Machine Co.
IOWA MFG. CO.
Johnson-March Corp.
Joy Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Kirk & Blum Mfg. Co.
Koppers Co., Inc. Metal Prod. Div.
Mahon Co., R. C.
Malac Inc.
McNally Pittsburg Mfg. Corp.
MINE SAFETY APPLIANCES CO.
NORTHERN BLOWER CO.
Ogden Iron Works
Pangborn Corp.
Pioneer Engineering Div. Poor & Co. Inc.
Pulverizing Machinery Div., Metals Disintegrating Co., Inc.
Research-Cottrell, Inc.
Santa Fe Tank Div. Fluor Products Co.
Schneible Co, Claude B.
Sly Mfg. Co., W. W.
Standard Electrical Tool Co.
Stanley Co., Inc., William W.
U. S Electrical Tool Co.
U. S. Hoffman Machinery Corp. Air Appliance Div.
Western Precipitation Corp.
Westinghouse Electric Corp. Sturtevant Div.
Wheelabrator Corp.

DUST SAMPLERS

Dustex Corp.
MINE SAFETY APPLIANCES CO.
Staplex Co. Air Sampler Div.
Western Precipitation Corp.

E

ELECTRICAL BRUSHES

Carbon Engineering Corp.
Carbone Corp.
Helwig Co.
Keystone Carbon Co.
National Carbon Co. Union Carbide Corp.
National Mine Service Co.
Northwestern Electric Co.
Ohio Carbon Co.
Pure Carbon Co.
Southern Carbon Brush Co.
Speer Carbon Co.
Stackpole Carbon Co.
Westinghouse Electric Corp.

ELECTRICAL CONDUIT, RACEWAYS & FITTINGS —also see Pipe

American Brass Co.
Appleton Electric Co.
Byers Co., A. M.
Circle Wire & Cable Corp.
Crouse Hinds Co.
Electrical Fittings Corp.
Flexaust Co.
Franklin Plastics Co.
General Cable Corp.
General Electric Co. Construction Materials Div.
Graybar Elec. Co., Inc.
Johns-Manville
Killark Electric Mfg. Co.
Line Material Industries McGraw-Edison Co.
National Electric Products Corp. Gateway Center
NATIONAL SUPPLY CO.
Parker Electrical Mfg. Co.
Pittsburgh Reflector Co.
Pyle-National Co.
Rattan Mfg. Co.
Rome Cable Corp.
Steel City Electric Co.
Steelduct Co.
Thomas & Betts Co.
Triangle Conduit & Cable Co., Inc.
U. S. Rubber Co. Mechanical Goods Div.
V. V. Fittings Co.
Wadsworth Electric Mfg. Co.
Walker Brothers
Youngstown Sheet & Tube Co.

(ELECTRICAL CONTROLS— —see Controls)

(ELECTRICAL INSULATING MATERIALS—see Insulating Materials, Electrical)

ELECTRIC BATTERIES, DRY & STORAGE

Auto-Lite Battery Corp.
Bowers Battery & Spark Plug Co.
Bright Star Industries
Burgess Battery Co.
C & D Batteries, Inc.
Carbone Corp.
Edison, Inc., T. A. Edison Storage Battery Div.
ELECTRIC STORAGE BATTERY CO. EXIDE INDUSTRIAL DIV.
Goodrich Co., B. F. Truck & Bus Tire Dept.
Gould-National Batteries, Inc.
Graybar Elec. Co., Inc.
K. W. Battery Co.
National Carbon Co. Union Carbide Corp.
Ray-O-Vac Co.
Yardney Electric Corp.

ELECTRIC BATTERY CHARGERS

American Rectifier Corp. Selenicharger Div.

Automatic Switch Co.
C & D Batteries, Inc.
Electric Specialty Co.
ELECTRIC STORAGE BATTERY CO. EXIDE INDUSTRIAL DIV.
General Electric Co. Apparatus Sales Div.
General Nuclear Corp.
Goodrich Co., B. F. Truck & Bus Tire Dept.
Gould-National Batteries, Inc.
Graybar Elec. Co., Inc.
Hertner Electric Co.
Hobart Bros. Co.
Hose-McCann Telephone Co.
Ironton Engine Co.
K. W. Battery Co.
Kersey Mfg. Co., Inc.
Knopp, Inc.
Lincoln Electric Co.
Marquette Mfg. Co., Inc.
National Mine Service Co.
Northwestern Electric Co.
Onan & Sons, Inc., D. W.
Perkin Engineering Corp.
Quick Charge Inc.
Syntron Co.
Westinghouse Electric Corp.
Wincharger Corp.
Yardney Electric Corp.

ELECTRIC BATTERY TRANSFER RACKS

Graybar Elec. Co., Inc.

ELECTRIC CABLE & WIRE —other than below

Alphaduct Wire & Cable Co.
American Brass Co.
American Steel & Wire Div. U. S. Steel Corp.
ANACONDA WIRE & CABLE CO.
Ansonia Wire & Cable Co.
Auto-Lite Battery Corp.
Chester Cable Corp.
Circle F Mfg. Co.
Circle Wire & Cable Corp.
Collyer Insulated Wire Co.
Copperweld Steel Co.
Crescent Insulated Wire & Cable Co.
Ettco Wire & Cable Corp.
General Cable Corp.
General Electric Co. Construction Materials Div.
Graybar Elec. Co., Inc.
Kerite Co.
MACHINERY CENTER INC.
National Electric Products Corp.
Okonite Co
Paranite Wire & Cable Div. Essex Wire Corp.
Phelps Dodge Copper Products Corp.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Rockbestos Products Corp. Reynolds Metals Co.
Roebling's Sons Corp., John A. Subsidiary of Colorado Fuel & Iron Co.
Rome Cable Corp.
SIMPLEX WIRE & CABLE CO.
Tennessee Coal & Iron Div. U. S. Steel Corp.
Triangle Conduit & Cable Co., Inc.
Walker Brothers
Western Insulated Wire Co.

ELECTRIC CABLE, ARMORED

Alumimum Co. of America
American Steel & Wire Div. of U. S. Steel Corp.
ANACONDA WIRE & CABLE CO.
Ansonia Wire & Cable Co.
Chester Cable Corp.
Circle Wire & Cable Corp.
Collyer Insulated Wire Co.
Crescent Insulated Wire & Cable Co.
Ettco Wire & Cable Corp.
General Cable Corp.
General Electric Co. Construction Materials Div.
Graybar Elec Co., Inc.
Kaiser Aluminum & Chemical Sales, Inc.
Kerite Co.
MACHINERY CENTER INC.
National Electric Products Corp. Gateway Center
Okonite Co.
Paranite Wire & Cable Div. Essex Wire Corp.
Phelps Dodge Copper Products Corp.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Rochester Ropes, Inc.
Rockbestos Products Corp.
Roebling's Sons Corp., John A. Subsidiary of Colorado Fuel & Iron Corp.
Rome Cable Corp.
SIMPLEX WIRE & CABLE CO.
Tennessee Coal & Iron Div. U. S. Steel Corp
Triangle Conduit & Cable Co., Inc.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.

ELECTRIC CABLE, NON METALLIC SHEATHED

Aluminum Co. of America
American Steel & Wire Div. U. S. Steel Corp.
ANACONDA WIRE & CABLE CO.
Ansonia Wire & Cable Co.
Auto-Lite Battery Corp.
Chester Cable Corp.
Circle Wire & Cable Corp.
Collyer Insulated Wire Co.
Crescent Insulated Wire & Cable Co.
Ettco Wire & Cable Corp.
General Cable Corp.
General Electric Co. Construction Materials Div.
Graybar Elec. Co., Inc.
Kerite Co.
National Electric Products Corp. Gateway Center
Okonite Co.
Paranite Wire & Cable Div. Essex Wire Corp.
Phelps Dodge Copper Products Corp.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Rockbestos Products Corp.
Rome Cable Corp.
SIMPLEX WIRE & CABLE CO.
Tennessee Coal & Iron Div. U. S. Steel Corp.
Triangle Conduit & Cable Co., Inc.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
Walker Brothers
Western Insulated Wire Co.

ELECTRIC CABLE, TRAILING

Aluminum Co. of America
American Steel & Wire Div. U. S. Steel Corp.
ANACONDA WIRE & CABLE CO.
Ansonia Wire & Cable Co.
Circle Wire & Cable Corp.
Collyer Insulated Wire Co.
Crescent Insulated Wire & Cable Co.
General Cable Corp.
General Electric Co., Construction Materials Div.
Graybar Elec. Co., Inc.
Okonite Co.
Parantie Wire & Cable Div. Essex Wire Corp.
Phelps Dodge Copper Products Corp.
Pickard Industries Inc. Central Mine Supply Co., Div.
Roebling's Sons Corp., John A. Subsidiary of Colorado Fuel & Iron Co.
Rome Cable Corp.
SIMPLEX WIRE & CABLE CO.
Tennessee Coal & Iron Div. U. S. Steel Corp.
Triangle Conduit & Cable Co., Inc.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
Western Insulated Wire Co.

ELECTRIC CABLE ACCESSORIES & FITTINGS

Aluminum Co. of America
ANACONDA WIRE & CABLE CO.
Anderson Mfg. Co., Albert & J. M.
Appleton Electric Co.
Auto-Lite Battery Corp.
Burndy Corp.
Electrical Fittings Corp.
Elreco Corp.
G. & W. Electric Specialty Co.
Graybar Elec. Co., Inc.
Joy Mfg. Co.
Memco Engineering & Mfg. Co.
National Electric Products Corp. Gateway Center
Ohio Brass Co.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Powercraft Corp.
Pyle-National Co.
Rattan Mfg. Co.
Steel City Electric Co.
Thomas & Betts Co.

ELECTRIC CABLE SPLICERS & VULCANIZERS

AMERICAN MINE DOOR CO.
Clark Controller Co.
Deltron Electric Products, Inc.
Flood City Brass & Elec. Co.
Irvington Div. Minnesota Mining & Mfg. Co.
Joy Mfg. Co.
MINE SAFETY APPLIANCES CO.
Minnesota Mining & Mfg. Co.
Pickard Industries. Inc. Central Mine Supply Co., Div.

ELECTRIC GENERATORS — does not include: Power Plants, engine- or motor-generator sets, or Rectifiers

Allis-Chalmers Mfg. Co. Industries Group
Allis Co., Louis
Auto-Lite Battery Corp.
Century Electric Co.
Columbia Electric Mfg. Co.
Continental Electric Co., Inc.
Electric Machinery Mfg. Co.
Electric Specialty Co.
Elliott Co.
Fairbanks, Morse & Co.
General Electric Co. Apparatus Sales Div.
Graybar Elec. Co. Inc.
Hertner Electric Co.
Ideal Electric & Mfg. Co.
Kato Engineering Co.
Kurz & Root Co.
Leland Electric Co., Div. American Machine & Foundry Co.
Marathon Electric Mfg. Corp.
Marble Card Electric Corp.
Master Electric Co.
Miehle Printing Press & Mfg. Co. Star-Kimble Motor Div.
Northwestern Electric Co.
Ohio Brass Co.
Onan & Sons, Inc., D. W.
Troy Engine & Machine Co.

ELECTRIC GENERATING POWER PLANTS, MOBILE & MOVABLE

Alco Products, Inc.
Allis-Chalmers Mfg. Co. Engine-Material Handling Div.
American MARC, Inc.
BABCOCK & WILCOX CO.
Beech Aircraft Corp.
Caterpillar Tractor Co.
Chicago Pneumatic Tool Co.
Climax Engine Mfg. Co., Div. Waukesha Motor Co.
Detroit Diesel Engine Div. General Motors Corp.
DIESEL ENERGY CORP.
Fairbanks, Morse & Co.
General Electric Co. Apparatus Sales Div.
Graybar Elec. Co., Inc.
Harnishfeger Corp. P & H Diesel Div.
Hobart Bros. Co.
Homelite Div., Textron Inc.
Ideal Electric & Mfg. Co.
Kato Engineering Co.
Kurz & Root Co.
Lister-Blackstone, Inc.
Marathon Electric Mfg. Corp.
Miehle Printing Press & Mfg. Co. Star-Kimble Motor Div.
Murphy Diesel Co.
NORDBERG MFG. CO.
Northwestern Electric Co.
Onan & Sons, Inc., D. W.
Pyle-National Co.
Ready Power Co.
Sheppard Co., Inc., R. H.
Thor Power Tool Co.
Universal Motor Co.
Waukesha Motor Co.
Westinghouse Electric Corp.
WHITE DIESEL ENGINE DIV. WHITE MOTOR CO.
Wincharger Corp.
Witte Engine Works, Oil Well Supply Div. U. S. Steel Corp.

ELECTRIC GENERATING POWER PLANTS, STATIONARY

Alco Products, Inc.
Allis-Chalmers Mfg. Co.
American MARC Inc.
BABCOCK & WILCOX CO.
Caterpillar Tractor Co.
Condenser Service & Engineering Co.
Continental Electric Co., Inc.
Cooper-Bessemer Corp.
Detroit Diesel Engine Div. General Motors Corp.
DIESEL ENERGY CORP.
Fairbanks, Morse & Co.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
Hertner Electric Co.
Hobart Bros. Co.
Ideal Electric & Mfg. Co.
Kato Engineering Co.
Lister-Blackstone, Inc.
NORDBERG MFG. CO.
Northwestern Electric Co.
Onan & Sons, Inc., D. W.
Pyle-National Co.
Ready Power Co.
Terry Steam Turbine Co.
Universal Motor Co.
Waukesha Motor Co.
Westinghouse Electric Corp.
WHITE DIESEL ENGINE DIV. WHITE MOTOR CO.
Wincharger Corp.
Witte Engine Works Oil Well Supply Div. U. S. Steel Corp.

ELECTRIC MOTORS — does not include Gear Motors

Acme Machinery Co.
Allis-Chalmers Mfg. Co. Industries Group
Allis Co., Louis
Armor Electric Mfg. Co.
Auto-Lite Battery Corp.
Century Electric Co.
Cleveland Electric Motor Co.
Continental Electric Co., Inc.
Diehl Mfg. Co.
Electric Machinery Mfg. Co.
Electric Specialty Co.
Electro Dynamic Div. General Dynamics Corp.
Elliott Co.
Fairbanks, Morse & Co.
General Electric Co. Apparatus Sales Div.
Graybar Elec. Co., Inc.
Hertner Electric Co.
Howell Electric Motors Co.
Ideal Electric & Mfg. Co.
Imperial Electric Co.
Kato Engineering Co.
Kurz & Root Co.
Leland Electric Co., Div. American Machine & Foundry Co.
Lima Electric Motor Co.
Lincoln Electric Co.
Marathon Electric Mfg. Corp.
Marble Card Electric Corp.
Master Electric Co.
Miehle Printing Press & Mfg. Co. Star-Kimble Motor Div.
Northwestern Electric Co.
Ohio Electric Mfg. Co.
Peerless Electric Co.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Reliance Electric & Engineering Co.
Robbins & Myers, Inc., Motor Div.
Smith Co., A. O.
Sterling Electric Motors, Inc.
U. S. Electrical Motors, Inc.
Wagner Electric Corp.
Western Gear Corp.
Westinghouse Electric Corp.
Wincharger Corp.

ELECTRIC MOTORS, PROTECTED

Acme Machinery Co.
Allis-Chalmers Mfg. Co. Industries Group
Allis Co., Louis
Armor Electric Mfg. Co.
Baldor Electric Co.
Century Electric Co.
Cleveland Electric Motor Co.
Continental Electric Co., Inc.
Diehl Mfg. Co.
Electric Machinery Mfg. Co.
Electric Specialty Co.
Electro Dynamic Div. General Dynamics Corp.
Elliott Co.
Fairbanks, Morse & Co.
General Electric Co. Apparatus Sales Div.
Graybar Elec. Co., Inc.
Howell Electric Motors Co.
Ideal Electric & Mfg. Co.
Imperial Electric Co.
Kurz & Root Co.
Lima Electric Motor Co.
Lincoln Electric Co.
Marathon Electric Mfg. Corp.
Marble Card Electric Corp.
Master Electric Co.
Miehle Printing Press & Mfg. Co. Star-Kimble Motor Div.
Northwestern Electric Co.
Ohio Electric Mfg. Co.
Peerless Electric Co.
Reliance Electric & Engineering Co.
Robbins & Myers, Inc.
Sterling Electric Motors, Inc.
U. S. Electrical Motors, Inc.
Wagner Electric Corp.
Western Gear Corp.
Westinghouse Electric Corp.
Wincharger Corp.

ELECTRIC MOTOR CONTROLS & STARTERS—also

see: Controls; Electric Resistors; Electric Switchgear

Acme Machinery Co.
Allen-Bradley Co.
Allis-Chalmers Mfg. Co. Industries Group
Allis Co., Louis
Armco Electric Mfg. Co.
Arrow Hart & Hegeman Electric Co.
Auto-Lite Battery Corp.
Automatic Switch Co.
Black & Decker Mfg. Co.
Bristol Co.
CARPCO MFG., INC.
Clark Controller Co.
Cutler-Hammer, Inc.
Electric Controller & Mfg. Co. Div. Square D. Co.
Electric Materials Co.
Electrical Machinery Mfg. Co.
Ensign Electric & Mfg. Co.
Federal Pacific Electric Co.
General Electric Co. Apparatus Sales Div.
General Equipment & Mfg. Co.
Graybar Elec. Co., Inc.
Guyan Machy. Co.
Ideal Electric & Mfg. Co.
Kato Engineering Co.
Kurz & Root Co.
National Mine Service Co.
Northwestern Electric Co.
Ohio Brass Co.
Parker Electrical Mfg. Co.
Pyle-National Co.
Reliance Electric & Engineering Co.
Westinghouse Electric Corp.

ELECTRIC RECTIFIERS, MECHANICAL

General Electric Co. Apparatus Sales Div.
I-T-E Circuit Breaker Co.
Kersey Mfg. Co., Inc.

ELECTRIC RECTIFIERS, MERCURY ARC

Allis-Chalmers Mfg. Co. Industries Group
General Electric Co. Apparatus Sales Div.
General Electric Co. Ind. Haulage Div. Loco. & Car Equip. Divs.
Reliance Electric & Engineering Co.
Westinghouse Electric Corp.

ELECTRIC RECTIFIERS, MOTOR-GENERATOR SETS

Allis-Chalmers Mfg. Co. Industries Group
Allis Co., Louis
Columbia Electric Mfg. Co.
Continental Electric Co., Inc.
Electro Dynamic Div. General Dynamics Corp.
General Electric Co. Apparatus Sales Div.
Graybar Elec. Co., Inc.
General Motors Corp. Electro-Motive Div.
Hertner Electric Co.
Ideal Electric & Mfg. Co.
Kato Engineering Co.
Kersey Mfg. Co., Inc.
Kurz & Root Co.
Leland Electric Co., Div. American Machine & Foundry Co.
Marathon Electric Mfg. Corp.
Marble Card Electric Corp.
Master Electric Co.
Miehle Printing Press & Mfg. Co. Star-Kimble Motor Div.
Northwestern Electric Co.
Reliance Electric & Engineering Co.
Sangamo Electric Co.
Westinghouse Electric Corp.

ELECTRIC RECTIFIERS, SELENIUM & RARE METAL

Allis-Chalmers Mfg. Co. Industries Group
American Rectifier Corp.
Baldor Electric Co.
Clark Controller Co.
General Electric Co. Apparatus Sales Div.
General Nuclear Corp.
Graybar Elec. Co., Inc.
I-T-E Circuit Breaker Co.
K. W. Battery Co.
Kersey Mfg. Co., Inc.
Knopp, Inc.
Perkin Engineering Co.
Shrader Co., F. W.
Syntron Co.
Union Switch & Signal Div., Westinghouse Air Brake Co.
Westinghouse Electric Corp.
Whiting Corp.

ELECTRIC RECTIFIERS, VACUUM TUBE (ELECTRONIC)

Allis-Chalmers Mfg. Co. Industries Group
Baldor Electric Co.
General Electric Co. Apparatus Sales Div.
General Equipment & Mfg. Co.
Graybar Elec. Co., Inc.
Reliance Electric & Engineering Co.
Westinghouse Electric Corp.

ELECTRIC RECTIFIERS, SYNCHRONOUS CONVERTER

Allis-Chalmers Mfg. Co. Industries Group
General Electric Co. Apparatus Sales Div.
Graybar Elec. Co., Inc.
Kato Engineering Co.
Universal Dredge Mfg. Co.
Westinghouse Electric Corp.

ELECTRIC RECTIFIERS, SPECIAL OR OTHER THAN ABOVE

Allis-Chalmers Mfg. Co. Industries Group
American Rectifier Corp.
CARPCO MANUFACTURING, INC.
Curtiss-Wright Corp. Electronics Div.
General Electric Co. Apparatus Sales Div.
General Equipment & Mfg. Co.
Graybar Elec. Co., Inc.
Northwestern Electric Co.
Perkin Engineering Corp.
Union Switch & Signal Div., Westinghouse Air Brake Co.

ELECTRIC RESISTORS & RHEOSTATS

Clark Controller Co.
Cutler-Hammer Inc.
General Electric Co., Apparatus Sales Div.
Ohio Carbon Co.

ELECTRIC SWITCHGEAR & SWITCHES — also see: Electrical brushes; Controls, Electrical; Meters, Electrical; Electric Trolley Accessories

Allen-Bradley Co.
Allis-Chalmers Mfg. Co. Industries Group
Anderson Mfg. Co., Albert & J. M.
Arrow Hart & Hegeman Electric Co.
Automatic Switch Co.
Bethlehem Foundry & Machine Co.
Bulldog Electric Products Co.
CHEATHAM ELECTRIC SWITCHING DEVICE CO.
Circle F Mfg. Co.
Clark Controller Co.
Cutler-Hammer, Inc.
Delta-Star Electric Div. H. K. Porter Company, Inc.
Durakool, Inc.
Electric Controller & Mfg. Co. Div. Square D. Co.
Electronic Machinery Mfg. Co.
Federal Pacific Electric Co.
G. & W. Electric Specialty Co.
General Electric Co., Apparatus Sales Div.
General Equipment & Mfg. Co.
General Switch Co., Div. Norbute Div.
Graybar Elec. Co., Inc.
Guyan Machy. Co.
Heinemann Electric Co.
I-T-E Circuit Breaker Co.
Ideal Electric Mfg. Co.
Kolton Electric Mfg. Co.
Kurz & Root Co.
Lake Shore Electric Mfg. Corp.
Line Material Industries McGraw-Edison Co.
Memco Engineering & Mfg. Co.
Minneapolis-Honeywell Regulator Co. Micro Switch Div.
Nachod & U. S. Signal Co.
National Filter Media Corp.
Northwestern Electric Co.
Parker Electrical Mfg. Co.
Powercraft Corp.
V. V. Fittings Co.
Wadsworth Electric Mfg. Co.
Westinghouse Electric Corp.

ELECTRIC TRANSFORMERS —also see Unit Substations below

Allis-Chalmers Mfg. Co. Industries Group
Burt n Equipment Co.; Inc.
Eitler Engineering Co.
Federal Pacific Electric Co.
General Electric Co. Apparatus Sales Div.
Graybar Elec. Co., Inc.
Hevi-Duty Electric Co.
I-T-E Circuit Breaker Co.
Knopp, Inc.
Kolton Electric Mfg. Co.
Kuhlman Electric Co.
Line Material Industries McGraw-Edison Co.
Moloney Electric Co.
Northwestern Electric Co.
Sangamo Electric Co.
Sorgel Electric Co.
Southwestern Industrial Electronics Co.
Standard Transformer Co.
Wagner Electric Corp.
Westinghouse Electric Corp.

ELECTRIC TROLLEY ACCESSORIES

Anderson Mfg. Co., Albert & J. M.
Arizona Testing Laboratories
Chariton Laboratories
CHEATHAM ELECTRIC SWITCHING DEVICE CO.
Deltron Electric Products, Inc.
Duquesne Mine Supply Co.
Electric Materials Co.
Elreco Corp.
Flood City Brass & Elec. Co.
Forker Corp.
General Equipment & Mfg. Co.
Gering Products, Inc.
Guyon Machinery Co.
Hales Co., W. M.
Nachod & U. S. Signal Co.
National Filter Media Corp.
Ohio Brass Co.
Root & Simpson, Inc.
Star Brass Works

ELECTRIC UNIT SUBSTATIONS

Allis-Chalmers Mfg. Co. Industries Group
BullDog Electric Products Co.
Federal Pacific Electric Co.
General Electric Co. Apparatus Sales Div.
Graybar Elec. Co., Inc.
Hevi-Duty Electric Co.
I-T-E Circuit Breaker Co.
Kolton Electric Mfg. Co.
Kuhlman Electric Co.
Line Material Industries McGraw-Edison Co.
Memco Engineering & Mfg. Co.
Moloney Electric Co.
Sorgel Electric Co.
Standard Transformer Co.
Wagner Electric Corp.
Westinghouse Electric Corp.

ELECTRIC VOLTAGE REGULATORS

Allis-Chalmers Mfg. Co. Industries Group
Allis Co., Louis
Auto-Lite Battery Corp.
Curtiss-Wright Corp. Electronics Div.
Electric Machinery Mfg. Co.
General Electric Co. Apparatus Sales Div.
Graybar Elec. Co., Inc.
Line Material Industries McGraw-Edison Co.
Moloney Electric Co.
Northwestern Electric Co.
Perkin Engineering Co.
Reliance Electric & Engineering Co.
Westinghouse Electric Corp.

ELEVATORS, PLANT BUILDINGS (MAN & MATERIAL) —does not include: Conveyors; Hoists (Mine)

Bartlett & Snow Co., C. O.
Bodinson Manufacturing Co., Inc.
Hapman Conveyors, Inc.
O. K. Machinery Div. John C. Motter Printing Press Co.
Stephens-Adamson Mfg. Co.
Transport Trailers, Inc
Westinghouse Electric Corp.

ENGINES, DIESEL

Alco Products, Inc.
Allis-Chalmers Mfg. Co., Engine-Material Handling Div.
American MARC, Inc.
Atlas Copco Pacific, Inc.
Canadian Locomotive Co., Ltd.
Case Co., J. I. Industrial Div.
Caterpillar Tractor Co.
Chicago Pneumatic Tool Co.
Compton, Inc.
Continental Motors Co.
Cooper-Bessemer Corp.
Cummins Engine Co., Inc.
Detroit Diesel Engine Div. General Motors Corp.
DIESEL ENERGY CORP.
Fairbanks, Morse & Co.
GARDNER DENVER CO.
General Motors Corp. Electro-Motive Div.
HARNISCHFEGER CORP.
Harnischfeger Corp. P & H Diesel Div.
HERCULES MOTORS CORP.
INGERSOLL-RAND CO.
International Harvester Export Co.
Lister-Blackstone, Inc.
Murphy Diesel Co.
NORDBERG MFG. CO.
Oliver Corp.
Onan & Sons, Inc., D. W.
Sheppard Co., Inc., R. H.
Waukesha Motor Co.
Witte Engine Works Oil Well Supply Div. U. S. Steel Corp.
WHITE DIESEL ENGINE DIV. WHITE MOTOR CO.
Worthington Corp.

ENGINES, GAS & GASOLINE

Allis-Chalmers Mfg. Co., Engine-Material Handling Div.
Briggs & Stratton Corp.
Canadian Locomotive Co., Ltd.
Case Co., J. I. Industrial Div.
Caterpillar Tractor Co.
Chicago Pneumatic Tool Co.
Climax Engine Mfg. Co., Div. Waukesha Motor Co.
Continental Motors Co.
DIESEL ENERGY CORP.
Fairbanks, Morse & Co.
Ford Motor Co.
HERCULES MOTORS CORP.
International Harvester Export Co.
Mustang Motor Products Corp.
NORDBERG MFG. CO.
Oliver Corp.
Onan & Sons, Inc., D. W.
Reo Motors, Inc.
Solar Aircraft Co.
Waukesha Motor Co.
Westinghouse Air Brake Co.
WHITE DIESEL ENGINE DIV. WHITE MOTOR CO.
Wisconsin Motor Corp.
Witte Engine Works Oil Well Supply Div. U. S. Steel Corp.

ENGINES, HYDRAULIC TURBINE

Allis-Chalmers Mfg. Co. Industries Group
Davis Foundry & Machine Works
Leffel & Co., James

ENGINES, STEAM

Condenser Service & Engineering Co.
Pyle-National Co.
Skinner Engine Co.
Troy Engine & Machine Co.

ENGINE EXHAUST SCRUBBERS

Drott Mfg. Co.
EIMCO CORP.
General Electric Co. Ind. Haulage Div. Loco. & Car Equip. Divs.
International Harvester Export Co.
Landis Steel Co.
Robinson Ventilating Co.
Ruth Co.
Telluride Iron Works Co.

(EXCAVATORS — see below; also see: Dredges; Loaders; Monitors; Scrapers; Trac-

tor Attachments; Buckets; Hoists; Winches)

EXCAVATORS, BUCKET WHEEL

Bucyrus-Erie Co.
Gar Wood Industries, Inc.

EXCAVATORS, CLAM SHELL & GRAB CRANE

American Hoist & Derrick Co.
AUSTIN-WESTERN CONSTRUCTION EQUIPMENT DIV. BALDWIN-LIMA-HAMILTON CORP.
Baldwin-Lima-Hamilton Corp., Lima Works, Construction Equipment Div.
Bay City Shovels, Inc.
Bucyrus-Erie Co.
Clark Equipment Co. Construction Machinery Div.
Gar Wood Industries, Inc.
HARNISCHFEGER CORP.
Hyster Co.
Insley Manufacturing Corp.
Koehring Div. of Koehring Co.
Link-Belt Speeder Corp.
Manitowoc Engineering Corp.
Marion Power Shovel Co.
Northwest Enginering Co.
Schield Bantam Co.
Thew Shovel Co.
Unit Crane & Shovel Corp.
Yaun Mfg. Co., Inc.

EXCAVATORS, DIPPER SHOVEL

American Hoist & Derrick Co.
Baldwin-Lima-Hamilton Corp., Lima Works, Construction Equipment Div.
Bay City Shovels, Inc.
Bucyrus-Erie Co.
Clark Equipment Co. Construction Machinery Div.
Gar Wood Industries, Inc.
HARNISCHFEGER CORP.
Insley Mfg. Corp.
Koehring Div. of Koehring Co.
Link-Belt Speeder Corp.
Manitowoc Engineering Corp.
Marion Power Shovel Co.
Northwest Engineering Co.
Pettibone Mulliken Corp.
Quick-Way Truck Shovel Co.
Schield Bantam Co.
Thew Shovel Co.
Unit Crane & Shovel Corp.

EXCAVATORS, DRAGLINE CRANE

American Hoist & Derrick Co.
Baldwin-Lima-Hamilton Corp., Lima Works. Construction Equipment Div.
Bay City Shovels, Inc.
Bucyrus-Erie Co.
Clark Equipment Co. Construction Machinery Div.
Gar Wood Industries, Inc.
HARNISCHFEGER CORP.
Insley Manufacturing Corp.
Koehring Div. of Koehring Co.
Link-Belt Speeder Corp.
Manitowoc Engineering Corp.
Marion Power Shovel Co.
Northwest Engineering Co.
Page Engineering Co.
Quick-Way Truck Shovel Co.
Schield Bantam Co.
Thew Shovel Co.
Unit Crane & Shovel Corp.
Yaun Mfg. Co., Inc.

EXCAVATOR, DRAGLINE TOWER

EIMCO CORP.
SAUERMAN BROS., INC.

EXCAVATORS, DRAGLINE-SCRAPER, TOWER

(EXPLORATION EQUIPMENT — see: Surveying Equipment; Food, Packaged Kits; Tarpaulins; Geologist's Equip.; Geophysical Instruments; Transits, Pocket)

(EXPLOSIVES—see Blasting Compounds)

F

FANS & BLOWERS, AIR & GAS

American Air Filter Co., Inc.
American Blower Div. American-Standard
American Machine & Metals, Inc. De Bothezat Fans Div.
Binks Mfg. Co.
Buffalo Forge Co.
Chelsea Fan & Blower Co.
Clarage Fan Co.
COPPUS ENGINEERING CO.
DeLaval Steam Turbine Co.
Diehl Mfg. Co.
Duriron Co., Inc.
Fly Ash Arrestor Corp.
Fuller Co.
Guyan Machy. Co.
Hartzell Propeller Fan Co.
Hauck Mfg. Co.
Herold Mfg. Co.
Ilg Electric Ventilating Co.
INGERSOLL-RAND CO.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Koppers Co. Inc.
Lamson Corp.
Lehigh Fan & Blower Co. & Sutorbilt Corp., Fuller Co., Subsidiary General American Transportation Corp.
Martin Fan & Blower Co.
Maschinenfabrik Rudolf Hausherr & Soehne, GmbH c/o B. J. Nykerk Corp.
McNally Pittsburg Mfg. Corp.
Moore Co.
NORTHERN BLOWER CO.
Peerless Electric Co.
Robbins & Myers, Inc., Propellair Div.
Robinson Ventilating Co.
Roots-Connersville Blower Div. Dresser Industries Inc.
Sanford-Day Iron Works, Inc.
Spencer Turbine Co.
Standard Elec. Mfg. Co., Inc.
U. S. Hoffman Machinery Corp. Air Appliance Div.
Western Gear Corp.
Westinghouse Electric Corp.
Westinghouse, Electric Corp. Sturtevant Div.
Wing Mfg. Co., L. J.

FASTENERS — SCREWS, BOLTS, NAILS, SPIKES, NUTS, WASHERS, ETC.— does not include: Rock & Roof Bolts; Timber Connectors

Ackerman-Johnson Co.
American Steel & Wire Div. U. S. Steel Corp.
Ampco Metal, Inc.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Bristol Co.
Chicago Expansion Bolt Co.
COLUMBIA-GENEVA STEEL DIV., U. S. STEEL CORP.
Dicke Tool Co.
Dominion Steel & Coal Corp., Ltd.
Elastic Stop Nut Corp. of America
Frank, M. K.
General Steel Warehouse Co., Inc.
Gensco Tool Div.
Gibraltar Equipment & Mfg. Co.
Jones & Laughlin Steel Corp.
Lamson & Sessions Co.
Lewis Bolt & Nut Co.
Palnut Co.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Pittsburgh Screw & Bolt Co.
Pittsburgh Steel Co.
Republic Steel Corp.
Rockford Bolt & Steel Co.
St. Louis Screw & Bolt Co.
Sawyer Belt Hook & Wedge Co., Inc.
Sheffield Div. Armco Steel Corp.
Star Expansion
Strong, Carlisle & Hammond Co.
Tennessee Coal & Iron Div. U. S. Steel Corp.
Torrington Co., Progressive Mfg. Co. Div.

(FEEDERS — see below; also see: Bin & Chute Gates & Mechanisms; Conveyors; Grizzlies; Screens)

FEEDERS, CHAIN (ROSS TYPE)

DENVER EQUIPMENT CO.
DIESEL ENERGY CORP.
IOWA MFG. CO.
LINK-BELT CO.
ROSS SCREEN & FEEDER CO.

FEEDERS, CONSTANT WEIGHT & WEIGHING — also see Scales

ABCs Scale Div. McDowell Co., Inc.
Dwight-Lloyd Div. McDowell Co., Inc.
Erie Strayer Co.
HARDINGE CO., INC.
INDUSTRIAL PHYSICS & ELECTRONICS CO.
Jeffrey Mfg. Co.
MERRICK SCALE MFG. CO.
McDowell Co., Inc.
Omega Machine Co., Div. B-I-F Industries
Permutit Co., Div. Pfaudler Permutit Inc.
Richardson Scale Co.
SCHAFFER POIDOMETER CO.
Syntron Co.
Toledo Scale Co.
Wellman Engineering Co. McDowell Enterprise

FEEDERS, REAGENT, DRY

ABCs Scale Div. McDowell Co., Inc.
Dagley Mfg. Co.
DENVER EQUIPMENT CO.
Fisher & Porter Co.
LINK-BELT CO.
Jeffrey Mfg. Co.
Morse Bros. Machinery Co.
Omega Machine Co., Div. B-I-F Industries
Permutit Co., Div. Pfaudler Permutit Inc.
Savage Co., W. J.
Syntron Co.

FEEDERS, REAGENT, LIQUID

ABCs Scale Div. McDowell Co., Inc.
American Water Softener Co.
Brosites Products Corp.
Clarkson Co.
Dagley Mfg. Co.
DENVER EQUIPMENT CO.
Fisher & Porter Co.
Galigher Co.
Graver Water Conditioning Co.
Infilco, Inc.
MINE & SMELTER SUPPLY CO., MFG. DIV.
Minerals Engineering Co.
Morse Bros. Machinery Co.
Omega Machine Co., Div. B-I-F Industries
Permutit Co., Div. Pfaudler Permutit Inc.

FEEDERS, RECIPROCATING PLUNGER

Acme Road Machinery Co., Inc.
Bartlett & Snow Co., C. O.
Bodinson Manufacturing Co., Inc.
Carrier Conveyor Corp.
DENVER EQUIPMENT CO.
Gruendler Crusher & Pulverizer Co.
Hack Engineering Co.
Helmick Foundry-Machine Co.
HEWITT-ROBINS, INC.
Hirsch Bros. Machy. Co.
IOWA MFG. CO.
LINK-BELT CO.
Lippmann Engineering Works, Inc.
McNally Pittsburg Mfg. Corp.
McLanahan & Stone Corp.
Morse Bros. Machinery Co.
Proportioners, Inc., Div. B-I-F Industries
Pioneer Engineering Div. Poor & Co., Inc.
Rogers Iron Works Co.
Telluride Iron Works Co.
Universal Dredge Mfg. Co.

FEEDERS, REVOLVING DISK & PLATE

ALLEN-SHERMAN-HOFF CO.
Bartlett & Snow Co. C. O.
Birdsboro Steel Foundry & Machine Co.
Bodinson Manufacturing Co., Inc.
Bonded Scale & Machine Co.
CARPCO MFG., INC.
Chain Belt Co.
Continental Gin Co. Industrial Div.
Dagley Mfg. Co.
Deister Concentrator Co.
DENVER EQUIPMENT CO.
HARDINGE CO., INC.
HEWITT-ROBINS, INC.
Hirsch Bros. Machy. Co.
Infilco, Inc.
Jeffrey Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
LINK-BELT CO.
Morse Bros. Machinery Co.
NATIONAL IRON CO.
Pulva Corp.
Pulverizing Machinery Div., Metals Disintegating Co., Inc.
Stephens-Adamson Mfg. Co.
Telluride Iron Works Co.

FEEDERS, ROTARY, DRUM

Deister Concentrator Co.
Deister Machine Co.
Hack Engineering Co.
HARDINGE CO., INC.
Hirsch Bros. Machy. Co.
LINK-BELT CO.
Pulverizing Machinery Div., Metals Disintegrating Co., Inc.
Specialty Engineering Co.
Universal Dredge Mfg. Co.
WESTERN MACHINERY CO.

FEEDERS, ROTARY, VANE

ALLEN-SHERMAN-HOFF CO.
Bartlett & Snow Co., C. O.
Continental Gin Co. Industrial Div.
Davis Foundry & Machine Works
Engineered Equipment Inc.
Erie Strayer Co.
Fuller Co., Subsidiary General American Transportation Corp.
HEWITT-ROBINS, INC.
Hirsch Bros. Machy. Co.
Holmes & Bros., Inc. Robert
LINK-BELT CO.
Pulva Corp.
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
Wellman Engineering Co. McDowell Enterprise

FEEDERS, VIBRATING, SHAKING, ETC. (PLATE, TABLE, ETC.) — does not include Grizzlies or Screens

Acme Road Machinery Co., Inc.
Baldwin-Lima-Hamilton Corp. Construction Equipment Div.
Branford Co.
CARPCO MANUFACTURING, INC.
Carrier Conveyor Corp.
Chain Belt Co.
Cleveland Vibrator Co.
Diamond Iron Works Div. Goodman Mfg. Co.
Dravo Corp.
Eriez Mfg. Co.
Hack Engineering Co.
HEWITT-ROBINS, INC.
Industrial Engr. & Construction Co.
IOWA MFG. CO.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
LINK-BELT CO.
Lippmann Engineering Works, Inc.
NATIONAL IRON CO.
Overstrom & Sons, Inc.
Pioneer Engineering Div. Poor & Co. Inc.
Prins & Associates, K.
Richardson Scale Co.
Ridge Equipment Co.
Roberts & Schaefer Co., Subsidiary of Thompson Starrett Co., Inc.
Savage Co., W. J.
Simplicity Engineering Co.
Smith Engineering Works
Southwestern Engineering Co.
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
Syntron Co.
TRAYLOR ENGINEERING MFG. CO.
Universal Dredge Mfg. Co.
Universal Engineering Corp
Universal Road Machinery Co.

FENCING, METAL WIRE

American Chain & Cable Co., Inc., Page Steel & Wire Div.
American Steel & Wire Div. U. S. Steel Corp.
Bethlehem Steel Co., Inc.
COLORADO FUEL & IRON CORP.
Copperweld Steel Co.
Dominion Steel & Coal Corp., Ltd.
Jones & Laughlin Steel Corp.
Pittsburgh Steel Co.
Republic Steel Corp.
Sheffield Div. Armco Steel Corp.
Tennessee Coal & Iron Div. U. S. Steel Corp.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.

Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.

FILTERS, AIR, GAS & DUST

American Air Filter Co., Inc.
Convair, Inc.
DIESEL ENERGY CORP.
DUCON INC.
GARDNER DENVER CO.
Goodyear Tire & Rubber Co. Industrial Products
Goodyear Tire & Rubber Co.
Hazemag USA Inc.
Koppers Co., Inc. Metal Prod. Div.
Leavitt Machine Co.
Lincoln Engineering Co. Div. McNeil Machine Engineering Co.
Mahon Co., R. C.
MINE SAFETY APPLIANCES CO.
NORTHERN BLOWER CO.
Pulmosan Safety Equipment Corp.
Purolator Products, Inc.
Sly Mfg. Co., W. W.
Staplex Co. Air Sampler Div.
Uehling Instrument Co.
VICTOR EQUIPMENT CO. ALLOY ROD METAL DIV.
Western Precipitation Corp.
Westinghouse Air Brake Co. Ind. Products Div.
Wheelabrator Corp.
Whiting Corp.
Wilkerson Corp.
Winslow Engineering & Mfg. Co.

FILTERS, CONCENTRATE

Bird Machine Co.
Booth Co.
CARPCO MFG., INC.
Dagley Mfg. Co.
DENVER EQUIPMENT CO.
Dorr-Oliver, Inc.
Duriron Co., Inc.
EIMCO CORP.
Filtration Engineers, Inc. Sub. of American Machine & Metals, Inc.
Galigher Co.
HARDINGE CO., INC.
LINK-BELT CO.
Morse Bros. Machinery Co.
Peterson Filters & Engr. Co.
Shriver & Co., T.

FILTERS, ENGINE OIL, ETC.

Buffalo Hammer Mill Corp.
Marvel Engineering Co.
Newark Wire Cloth Co.
Purolator Products, Inc.
Schroeder Brothers Corp.
Shriver & Co., T.
U. S. Hoffman Machinery Corp. Air Appliance Div.
Winslow Engineering & Mfg. Co.

FILTERS, WATER & LIQUID

American Water Softener Co.
Arrow Tank Co. Inc.
Atlantic Tank Corp.
Bethlehem Pacific Coast Steel Corp.
Bird Machine Co.
Brosites Products Corp.
Buffalo Hammer Mill Corp.
Chicago Bridge & Iron Co.
Cochrane Corp.
Condenser Service & Engineering Co.
Corning Glass Works
Dorr-Oliver, Inc.
Duriron Co., Inc.
EIMCO CORP.
Filtration Engineers, Inc. Sub of American Machine & Metals, Inc.
Graver Water Conditioning Co.
HARDINGE CO., INC.
Infilco, Inc.
MINE & SMELTER SUPPLY CO., MFG. DIV.
Marvel Engineering Co.
Newark Wire Cloth Co.
Peterson Filters & Engr. Co.
Permutit Co., Div. Pfaudler Permutit Inc.
Purolator Products, Inc.
Shriver & Co., T.
U. S. Hoffman Machinery Corp. Air Appliance Div.
Winslow Engineering & Mfg. Co.

FILTER BAGS

Albany Felt Co.
Bemis Bro. Bag Co.
Brosites Products Corp.
Dagley Mfg. Co.
Daniels, Inc., C. R.
DUCON, INC.
EIMCO CORP.
Filtration Engineers, Inc. Sub. of American Machine & Metals, Inc.
Koppers Co., Inc. Metal Prod. div.
National Filter Media Corp.
NORTHERN BLOWER CO.
Pendleton Woolen Mills
Peterson Filters & Engr. Co.
Safety Clothing & Equipment Co.
Shriver & Co., T.
Sly Mfg. Co., W. W.
Stanley Co., Inc. William W.
Wheelabrator Corp.

FILTER CLOTH

Albany Felt Co.
Brosites Products Corp.
Buffalo Wire Works Co.
COLORADO FUEL & IRON CORP.
Dagley Mfg. Co.
Daniels, Inc., C. R.
EIMCO CORP.
Filtration Engineers, Inc. Sub. of American Machine & Metals, Inc.
House & Sons, Inc. Chas. W.
Ludlow-Saylor Wire Cloth Co.
Multi-Metal Wire Cloth Co., Inc.
National Filter Media Corp.
Newark Wire Cloth Co.
Pendleton Woolen Mills
Peterson Filters & Engr. Co.
Shriver & Co., T.
Sly Mfg. Co., W. W.
Stanley Co., Inc., William W.
Tyler Co., W. S.
U. S. Rubber Co.
Wellington Sears Co.
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.
Wilkerson Corp.

FILTER MEDIA (OTHER THAN BAGS & CLOTH)

American Air Filter Co. Inc.
American Water Softener Co.
Brosites Products Corp.
Condenser Service & Engineering Co.
DuPont de Nemours & Co., Inc. E. I. Fabrics Div.
Duriron Co., Inc.
EIMCO CORP.
Filtration Engineers, Inc. Sub of American Machine & Metals, Inc.
Graver Water Conditioning Co.
Johns-Manville
Koppers Co., Inc. Metal Prod. Div.
Marvel Engineering Co.
MINE SAFETY APPLIANCES CO.
Multi-Metal Wire Cloth Co., Inc.
National Filter Media Corp.
Norton Co.
Permutit Co., Div. Pfandler Permutit Inc.
Peterson Filters & Engr. Co.
Pettinos, Inc., George F.
Shriver & Co., T.

FIRE FIGHTING EQUIPMENT & SUPPLIES

Acme Rubber Mfg. Co.
Bullard Co., E. D.
Daniels, Inc., C. R.
Eastman-Pacific Co.
Elkhart Brass Mfg. Co., Inc.
Falcon Alarm Co., Inc.
Four Wheel Drive Auto Co.
Fyr-Fyter Co.
Gatke Corp.
Goodrich Industrial Products Co., B. F.
Grinnell Co., Inc.
Hamilton Rubber Mfg. Corp.
HEWITT-ROBINS, INC.
Kidde & Co., Inc., Walter
Pickard Industries, Inc.
Porto Pump Inc.
Pulmosan Safety Equipment Corp.
Quaker Rubber Div. H. K. Porter Co.
Scott Aviation Corp.
Snyder & Son, Inc., M. L.
Stop-Fire, Inc.
U. S. Rubber Co.

FIRST AID EQUIPMENT & SUPPLIES

Bullard Co., E. D.
MINE SAFETY APPLIANCES CO.
National Mine Service Co.
Pulmosan Safety Equipment Corp.
Safety Clothing & Equipment Co.
Scott Aviation Corp.

(FLOCCULATING AGENTS—see Water Clarification Chemicals)

FLOOD LIGHTS, CARBIDE

Linde Co. Union Carbide Corp.

FLOOD LIGHTS, ELECTRIC—also see Lighting Fixtures & Lamps

Appleton Electric Co.
Crouse Hinds Co.
General Electric Co., Apparatus Sales Div.
Guyon Machinery Co.
Joy Mfg. Co.
Line Material Industries McGraw-Edison Co.
MINE SAFETY APPLIANCES CO.
Multi Electrical Mfg. Co.
Phoenix Products Co.
Pittsburgh Reflector Co.
Pyle-National Co.
Steber Mfg. Co.
Westinghouse Electric Corp.

FLOTATION MACHINES

Booth Co.
Canadian Locomotive Co., Ltd.
Chain Belt Co.
DENVER EQUIPMENT CO.
DIESEL ENERGY CORP.
Galigher Co.
Garver Water Conditioning Co.
Infilco, Inc.
MACHINERY CENTER INC.
Morse Bros. Machinery Co.
National Tank & Pipe Co.
STEARNS ROGER MFG. CO.
U. S. Hoffman Machinery Corp.
WESTERN MACHINERY CO.

FLOTATION REAGENTS

AMERICAN CYANAMID CO., EXPLOSIVES & MINING CHEMICALS DEPT.
Armour Chemical Div.
Baker & Adamson Products, General Chemical Div., Allied Chemical Corp.
Canadian Industries Ltd.
Cyanamid International Mining Chemicals Dept.
Dewey & Almy Chemical Co., Div. W. R. Grace & Co.
Dow Chemical Co.
DuPont de Nemours & Co., E. I.
Emery Industries, Inc.
Farbwerke Hoechst, A.G.
General Mills, Inc.
HERCULES POWDER CO.
Heyden Newport Chemical Corp.
Marathon Corp. Chemical Sales Dept.
Oronite Chemical Co.
Pacific Lumber Co.
Pennsalt Chemicals Corp.
Phelps Dodge Refining Corp.
Philadelphia Quartz Co.
Reilly Tar & Chemical Corp.
Stein, Hall & Co., Inc.
Union Carbide Chemicals Co. Union Carbide Corp.
West End Chemical Co.

(FLOTATION REAGENT FEEDERS—see Feeders)

FOOD, PACKAGED KITS

Bolton Farm Packing Co., Inc.

FORGES, BLACKSMITH, ETC.

Calumet Div. Calumet & Hecla, Inc.
Soang & Co.
STARDRILL-KEYSTONE CO.

FORGINGS, DROP, ET AL

Alco Products, Inc.
Aluminum Co. of America
American Brake Shoe Co.
American Car & Foundry Div. ACF Industries, Inc.
American Forge Co.
Atlas Steels, Ltd.
Bethlehem Pacific Coast Steel Corp.
Columbus Forge & Iron Co.
Conley Frog & Switch Co.
CRUCIBLE STEEL CO. OF AMERICA
Dominion Steel & Coal Corp., Ltd.
Duff Norton Co.
Duquesne Mine Supply Co.
Endicott Forging & Mfg. Co.
Giant Grip Mfg. Co.
Hayes Steel Products, Ltd.
Interstate Drop Forge Co.
Ladish Co.
Moore Drop Forging Co.
Mueller Brass Co.
NATIONAL SUPPLY CO.
New Departure Div., General Motors Corp.
Ohio Forge & Machine Corp.
Revere Copper & Brass, Inc.
Rockwell Spring & Axle Co. Timken-Detroit Axle Div.
Ryerson & Son, Inc., Joseph T.
Sxcokum Co., Inc.
Tennessee Coal & Iron Div. U. S. Steel Corp.
Titan Metal Mfg. Co.
Webb Co., Jervis B.

FREEZEPROOFING MATERIALS — does not include Concrete Additives

International Salt Co.
Morton Salt Co.
U. S. Rubber Co.

FURNACES, INDUSTRIAL PROCESS, COMBUSTION HEATED (HEATING, MELTING, ROASTING, SMELTING, CERAMIC, METALLURGICAL, REFRACTORY, ETC.) — does not include: Boilers; Burners; Dryers; Heaters; Laboratory Equipment; Retorts; Sintering Equipment; also see below and: Kilns, Converters

Denver Fire Clay Co.
DIESEL ENERGY CORP.
Leeds & Northrup Co.
Rockwell Co., W. S.
TREADWELL CO., M. H.
U. S. Smelting Furnace Co.
Whiting Corp.

FURNACES, INDUSTRIAL PROCESS, ELECTRIC HEATED (HEATING, MELTING, ROASTING, SMELTING, CERAMIC, METALLURGICAL, REFRACTORY, ETC.) — does not include: Boilers; Burners; Dryers; Heaters; Laboratory Equipment Retorts; Sintering Equipment; also see below and: Kilns, Converters

American Bridge Div., U. S. Steel Corp.
ASEA ELECTRIC INC.
ELEKTROKEMISK A. S.
General Electric Co., Apparatus Sales Div.
Harper Electric Furnace Corp.
Hevi-Duty Electric Co.
Lectromelt Furnace Div. McGraw Edison Co.

FURNACES, INDUSTRIAL PROCESS, FLUIDIZED SOLIDS

DIESEL ENERGY CORP.
Dorr-Oliver, Inc.
General Electric Co. Apparatus Sales Div.

(FURNACES, INDUSTRIAL PROCESS, ROTARY — see: Converters; Kilns)

FURNACES, INDUSTRIAL PROCESS, SHAFT (BLAST, CUPOLA, ETC.)

DIESEL ENERGY CORP.
Denver Fire Clay Co.
MINE & SMELTER SUPPLY CO., MFG. DIV.
Mace Co.
Pollock Co., William B.
TREADWELL CO., M. H.
Whiting Corp.

FURNACES, SHOP & BENCH (HEAT TREATING, MELTING, FORGING, ETC.) —

also see: Drill (Rock) Bit & Steel Forging & Heat Treating Furnaces; Forges; does not include Laboratory Equipment

Bigelow-Liptak Corp.
Blue M Electric Co.
Denver Fire Clay Co.
Hevi-Duty Electric Co.
General Electric Co. Apparatus Sales Div.
Leeds & Northrup Co.
Rockwell Co., W. S.

FURNACES, SMELTING AND ROASTING

Bethlehem Foundry & Machine
Bigelow Liptak
Colorado Iron Works Co.
Dorr-Oliver, Inc.
ELEKTOKEMISK, A. S.
GOULD, GORDON I.
Lectromelt Furnace Co. Div. McGraw-Electric Co.
Mace Co.
MINE & SMELTER SUPPLY CO., MFG. DIV.
Nichols Engineering & Research
Pacific Foundry Co. Ltd.
Salem-Brosius, Inc.
Stearns-Roger Mfg. Co.
TREADWELL CO., M. H.
U. S. Smelting Furnace Co.
Whiting Corp.

(FURNACE BURNERS — see Burners)

FURNACE CHARGERS

TREADWELL CO., M. H.
Whiting Corp.

FURNACE LININGS, WALL & ARCHES—also see Refractories

BABCOCK & WILCOX CO.
Bigelow-Liptak Corp.
Corhart Refractories
Denver Fire Clay Co.
Electro Refractories & Abrasives Corp.
General Refractories, Co.
Green Fire Brick Co., A. P.
Ironton Fire Brick Co.
Johns-Manville
Mexico Refractories Co.
Mullite Works Refractories Div. H. K. Porter Company, Inc.
Norton Co.
Pettinos, Inc. George F.
Quigley Co., Inc.
Refractory & Insulation Corp.
Reintjes Co., George P.
Robinson Clay Product Co.
STEARNS ROGER MFG. CO.

G

(GAGES—see Meters)

(GALVANOMETERS — see Meters, Electricity)

GASES, INDUSTRIAL (OXYGEN, HYDROGEN, CARBON DIOXIDE, ACETYLENE, ETC.)

Linde Co.
National Cylinder Gas Co.
Sun Oil Co.

GAS (& HUMIDITY) DETECTORS & INDICATORS — also see Meters, Chemical

American Instrument Co., Inc.
Brabender Corp.
Bristol Co.
Central Scientific Co.
Consolidated Electrodynamics Corp.
Curtiss-Wright Corp. Electronics Div.
Engelhard Industries Inc.
Fisher & Porter Co.
General Electric Co. Apparatus Sales Div.
MINE SAFETY APPLIANCES CO.
National Mine Service Co.
Permutit Co., Div. Pfaudler Permutit Inc.
Taller & Cooper, Inc.

GAS GENERATORS

Air Reduction Sales Co., Div. Air Reduction Co., Inc.
Engelhard Industries, Inc.
General Electric Co. Apparatus Sales Div.
Hevi-Duty Electric Co.
Industrial Air Products Co.
Linde Co. Union Carbide Corp.
National Cylinder Gas Co.
Sight Feed Generator Co.

GAS SEPARATION PROCESS EQUIPMENT (SPECIAL)—does not include Dust Collectors or standard auxiliary equipment

Black, Sivalls & Bryson, Inc.
Engelhard Industries Inc.
Graver Tank & Mfg. Co., Inc.
Process Engineering, Inc.
Standard Steel Corp.

GASKETS

Belmont Packing & Rubber Co.
Belmont Smelting & Refining Works, Inc.
Carey Mfg. Co., Philip
Chase Brass & Copper Co.
Felt Products Mfg. Co.
Garlock Packing Co.
Gatke Corp.
Godall Rubber Co.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co. Industrial Products
Goodyear Tire & Rubber Co.
Greene, Tweed & Co.
Hales Co., W. M.
Hayes Steel Products, Ltd.
HEWITT-ROBINS, INC.
Houghton & Co., E. F.
Johns-Manville
Metallo Gasket Co.
National Vulcanized Fibre Co.
New York Belting & Packing Co.
Quaker Rubber Div. H. K. Porter Co. Inc.
Raybestos-Manhattan, Inc. Manhattan Rubber Div.
Snyder & Son, Inc., M. L.
U. S. Rubber Co.

GEAR MOTORS — Also see: Drives; Electric Motors

Allis-Chalmers Mfg. Co. Industries Group
Allis Co., Louis
Brown, Inc., David
Century Electric Co.
Christian Engineers, J. D.
Cone-Drive Gears Div. Michigan Tool Co.
Electro Dynamic Div., General Dynamics Corp.
Elliott Co.
Fairbanks, Morse & Co.
FALK CORP.
Foote Bros. Gear & Machine Corp.
General Electric Co. Apparatus Sales Div.
Howell Electric Motors Co.
LINK-BELT CO.
Marble Card Electric Corp.
Master Electric Co.
Northwestern Electric Co.
Ohio Gear Co.
Philadelphia Gear Corp.
Reliance Electric & Engineering Co.
Sterling Electric Motors, Inc.
U. S. Electrical Motors, Inc.
Western Gear Corp.
Westinghouse Electric Corp.

(GEAR PULLERS — see Car Wheel & Gear Pullers)

GEARS & PINIONS, METAL —also see below

Acme Road Machinery Co., Inc.
American Brake Shoe Co. American Manganese Steel Div.
Ampco Metal, Inc.
Brad Foote Gear Works, Pittsburgh Gear Co. Div.
Brown, Inc., David
Christian Engineers, J. D.
Clark Equipment Co. Transmission Div.
Cone-Drive Gears Div., Michigan Tool Co.
CRUCIBLE STEEL CO. OF AMERICA
Culiman Wheel Co.
Davis Foundry & Machine Works
Eaton Mfg. Co.
FALK CORP.
Farrel-Birmingham Co., Inc.
Farrell-Cheek Steel Co.
Foote Bros. Gear & Machine Corp.
Frog, Switch & Mfg. Co.
General Electric Co. Gear Motor & Transmission Components Dept.
HEWITT-ROBINS, INC.
Hirsch Bros. Machy. Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kensington Steel Div., Poor & Co.
LINK-BELT CO.
Marathon Coal Bit Co., Inc.
Massachusetts Gear & Tool Co., Div., Geartronics Corp.
McNalty Pittsburg Mfg. Corp.
Ogden Iron Works
Ohio Gear Co.
Olds Alloy Co.
Penn Machine Co.
Perkins Machine & Gear Co.
Philadelphia Gear Corp.
Pittsburgh Gear Co.
Rockwell Spring & Axle Co. Timken-Detroit Axle Div.
Specialty Engineering Co.
Stahl Gear & Machine Co.
STEARNS ROGER MFG. CO.
Stroh Process Steel Co.
Tool Steel Gear & Pinion Co.
VULCAN IRON WORKS
West Virginia Armature Co.
Western Gear Corp.
Westinghouse Electric Corp.
Whitney Chain Co.

GEARS & PINIONS, METAL, LARGE (BALLMILL, MINE-SHAFT HOIST, ET AL)

Ampco Metal, Inc.
Birdsboro Steel Foundry & Machine Co.
Brad Foote Gear Works Pittsburgh Gear Co. Div.
Brown, Inc., David
Cone-Drive Gears Div., Michigan Tool Co.
CRUCIBLE STEEL CO. OF AMERICA
Davis Foundry & Machine Works
DeLaval Steam Turbine Co.
FALK CORP.
Farrel-Birmingham Co., Inc.
Farrell-Cheek Steel Co.
Foote Bros. Gear & Machine Corp.
Frog, Switch & Mfg. Co.
HEWITT-ROBINS, INC.
Hirsch Bros. Machy. Co.
Kanawha Mfg. Co.
LINK-BELT CO.
Ohio Gear Co.
Olds Alloy Co.
Philadelphia Gear Corp.
Pittsburgh Gear Co.
Sorel Steel Foundries, Ltd.
Stahl Gear & Machine Co.
STEARNS ROGER MFG. CO.
Stroh Process Steel Co.
Tool Steel Gear & Pinion Co.
VULCAN IRON WORKS
West Virginia Armature Co.
Western Gear Corp.
Westinghouse Electric Corp.

GEARS & PINIONS, NON-METALLIC

Brad Foote Gear Works Pittsburgh Gear Co. Div.
Continental-Diamond Fibre Corp. A Subsidiary of Budd Co.
Foote Bros. Gear & Machine Corp.
Gatke Corp.
HEWITT-ROBINS, INC.
Hirsch Bros. Machy. Co.
Massachusetts Gear & Tool Corp., Div. Geartronics Corp.
Menlo Research Laboratory
National Vulcanized Fibre Co.
Ohio Gear Co.
Perkins Machine & Gear Co.
Philadelphia Gear Works
Pittsburgh Gear Co.
Stahl Gear & Machine Co.
Synthane Corp.
West Virginia Armature Co.
Western Gear Corp.

(GEIGER COUNTERS — see Radiation Detectors)

GEOLOGIST'S EQUIPMENT (PICKS, POUCHES, ETC.) —does not include: Surveying Instruments; Drafting Equipment; Geophysical Instruments; Food: Packaged Kits; Laboratory Equip.

Collins Co.
Geophysical Instrument & Supply Co.
Stanley Tool Co.
Stratex Instrument Co.

GEOPHYSICAL INSTRUMENTS—does not include: Radiation Detectors; Ultra-Violet Lights

American Paulin System
Detectron Corp.
Engineers Syndicate, Ltd.
Failing Co., George E.
Fisher Research Laboratory, Inc.
Geo-Optic Co., Inc.
Geophysical Instrument & Supply Co.
Geophysical Specialties Co.
Goldak Co., Inc.
Houston Technical Laboratories
Jarrell-Ash Co.
McPhar Geophysics, Ltd.
McPhar Manufacturing, Ltd.
Mt. Sopris Instrument Co.
Seismograph Service Corp.
Southwestern Industrial Electronics Co.
Spartan Air Services
SPRENGNETHER INSTRUMENT CO., INC., W. F.
Texas Instruments, Inc. Industrial Instrumentation Div.
Universal Atomics Div. Universal Transistor Products Corp.
Ultra-Violet Products, Inc.
Varian Associates

GRADERS, ROAD, TOWED & SELF-PROPELLED

Allis Chalmers Mfg. Co. Construction Machy. Div.
AUSTIN-WESTERN CONSTRUCTION EQUIPMENT DIV. BALDWIN-LIMA-HAMILTON CORP.
Caterpillar Tractor Co.
Galion Iron Works
Huber-Warco Co.
LE TOURNEAU-WESTINGHOUSE CO.
Pettibone Mulliken Corp.
Westinghouse Air Brake Co.

GRATINGS, FLOOR

Bates Co., Walter
Blaw-Knox Co.
Borden Metal Products Co.
Dravo Corp.
Hendrick Mfg. Co.
Irving Subway Grating Co., Inc.
Klemp Metal Grating Corp.
Laubenstein Mfg. Co.
Ryerson & Son, Inc., Joseph T.

(GRINDERS & BUFFERS—see below; also see: Drill (Rock) Bit & Steel Grinders)

GRINDERS & BUFFERS, ELECTRIC

Baldor Electric Co.
Black & Decker Mfg. Co.
Blount Co., J. G.
Chicago Pneumatic Tool Co.
Cincinnati Electrical Tool Co.
Fisher Scientific Co.
Hisey-Wolf Machine Co.
INGERSOLL-RAND CO.
Lippmann Engineering Works, Inc.
Milwaukee Electric Tool Corp.
Queen City Machine Tool Co.
Ryerson & Son, Inc., Joseph T.
Standard Electrical Tool Co.
Stanley Electric Tools Div. Stanley Works
Thor Power Tool Co.
U. S. Electrical Tool Co.

GRINDERS & BUFFERS, PNEUMATIC

Atlas Copco Pacific, Inc.
Chicago Pneumatic Tool Co.
GARDNER DENVER CO.
Holman Bros.—Canada Ltd.
INGERSOLL-RAND CO.
Reed Roller Bit Co.
Stoody Co.
Thor Power Tool Co.

GRINDING (& CUTTING) WHEELS

American Emery Wheel Works

American Coldset Corp.
Atlas Copco Pacific, Inc.
Bay State Abrasive Products Co.
Chicago Wheel & Mfg. Co.
Electro Refractories & Abrasives Corp.
GARDNER DENVER CO.
Macklin Co.
Norton Co.
Peninsular Grinding Wheel Div.
Precision Grinding Wheel Co., Inc.
Raybestos-Manhattan, Inc. Manhattan Rubber Div.
Ryerson & Son, Inc., Joseph T.
Simonds Worden White Co.
Sterling Grinding Wheel Co.
Thor Power Tool Co.
U. S. Rubber Co. Mechanical Goods Div.
Waltham Grinding Wheel Co.

GRIZZLIES, FEEDING & MOVING

Acme Road Machinery Co., Inc.
Davis Foundry & Machine Works
HEWITT-ROBINS, INC.
Heyl & Patterson, Inc.
IOWA MFG. CO.
Jeffrey Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
LINK-BELT CO.
McLanahan & Stone Corp.
NATIONAL MALLEABLE & STEEL CASTINGS CO.
NORDBERG MFG. CO.
Rogers Iron Works Co.
ROSS SCREEN & FEEDER CO.
Simplicity Engineering Co.
Smith Engineering Works
Stephens-Adamson Mfg. Co.
Syntron Co.
Telluride Iron Works Co.
TRAYLOR ENGINEERING & MFG. CO.
Tyler Co., W. S.
Universal Engineering Corp.
Washington Machinery Co.

GRIZZLIES, STATIONARY

Acme Road Machinery Co., Inc.
American Brake Shoe Co. American Manganese Steel Div.
Baldwin-Lima-Hamilton Corp. Construction Equipment Div.
Bodinson Manufacturing Co., Inc.
CARD IRON WORKS, C. S.
COLORADO FUEL & IRON CORP.
Davis Foundry & Machine Works
Diamond Iron Works Div. Goodman Mfg. Co.
Hendrick Mfg. Co.
HEWITT-ROBINS, INC.
Hirsch Bros. Machy. Co.
Jeffrey Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Kenyon Walker Machinery Co.
LINK-BELT CO.
Lippmann Engineering Works, Inc.
Morse Bros. Machinery Co.
NATIONAL MALLEABLE & STEEL CASTINGS CO.
Ogden Iron Works
Pioneer Engineering Div. Poor & Co. Inc.
Smith Engineering Works
Stephens-Adamson Mfg. Co.
Telluride Iron Works Co.
TRAYLOR ENGINEERING & MFG. CO.
Tyler Co., W. S.
Universal Engineering Corp.
Universal Road Machinery Co.
Washington Machinery Co.
Yuba Consolidated Industries, Inc., Yuba Mining Div.

(GROUT PUMPS — see Concrete; Pumps)

H

HARDFACING ALLOYS & RODS—also see: Metallizing; Welding

Air Reduction Sales Co., Div. Air Reduction Co., Inc.
All-State Welding Alloys Co., Inc.
Alloy Rods Co.
American Brake Shoe Co. American Manganese Steel Div.
American Chain & Cable Co., Inc., Page Steel & Wire Div.
Ampco Metal, Inc.
Coast Metals, Inc.
CRUCIBLE STEEL CO OF AMERICA
Eutectic Welding Alloys Corp.
Hales Co., W. M.
Hard-N-Tuff Corp.
Haynes Stellite Co. Div. Union Carbide Corp.
Hobart Bros. Co.
Industrial Air Products Co.
Industrial Overlay Metals, Inc.
KENNAMETAL INC. MINING TOOL DIV.
Lincoln Electric Co.
Marquette Mfg. Co., Inc.
Metal & Thermit Corp.
Minerals Engineering Co.
National Cylinder Gas Co.
Norton Co.
Rankin Manufacturing Co.
Resisto-Loy Co., Inc.
Shwayder Chemical Metallurgy Corp.
Sight Feed Generator Co.
Stoody Co.
Stulz-Sickles Co.
VICTOR EQUIPMENT CO. ALLOY ROD & METAL DIV.

(HEATERS — see below; also see: Boilers; Dryers; Furnaces; Kilns; Retorts; Screen Heaters, Burners)

HEATERS, PROCESS, AIR & GAS (PRE-HEATERS, RECUPERATORS, REGENERATORS, ETC.)

BABCOCK & WILCOX CO.
Bigelow-Liptak Corp.
Carbone Corp.
Kennedy-Van Saun Mfg. & Eng. Corp.
Salem-Brosius, Inc.

HEATERS, SPACE — does not include: Boilers; Furnaces; Kilns; or Burners alone

Acme Electric Heating Co.
American Air Filter Co., Inc.
American Blower Div. American-Standard
Buffalo Forge Co.
Carrier Corp.
Clayton Mfg. Co.
Daniels, Inc., C. R.
Dravo Corp.
General Electric Co. Apparatus Sales Div.
Grinnell Co., Inc.
Guyan Machy. Co.
ILG Electric Ventilating Co.
Indiana Foundry Co.
Vulcan Electric Co.
Westinghouse Electric Corp. Sturtevant Div.
Wing Mfg. Co., L. J.

HEAT EXCHANGERS — also see: Boilers; Heaters; Coolers

BABCOCK & WILCOX
Canadian Locomotive Co., Ltd.
Christian Engineers, J. D.
Duriron Co., Inc.
Standard Steel Corp.
Yuba Consolidated Industries, Inc.

(HEAVY MEDIA SEPARATORS — see Separators, Heavy Media)

(HOISTS—see below; refer to Winches for type of power; also see: Cranes)

HOISTS, DREDGE, CRANE & SHOVEL TYPES

American Hoist & Derrick Co.
AUSTIN-WESTERN CONSTRUCTION EQUIPMENT DIV. BALDWIN-LIMA-HAMILTON CORP.
Baldwin-Lima-Hamilton Corp., Lima Works, Construction Equipment Div.
Clyde Iron Works, Inc.
Eagle Iron Works
HARNISCHFEGER CORP.
HEWITT-ROBINS, INC.
Hyster Co.
Koehring Co.
Lidgerwood Industries, Inc.
Link-Belt Speeder Corp.
Marion Power Shovel Co.
McKiernan-Terry Corp., Mead Morrison Div.
Reading Crane & Hoist Corp.
Rockwell Spring & Axle Co. Timken-Detroit Axle Div.
Superior-Lidgerwood-Mundy Corp.
Wiley Mfg. Co.
Yuba Consolidated Industries, Inc.

HOISTS, DRAGLINE SCRAPER-SLUSHER

American Hoist & Derrick Co.
GARDNER-DENVER CO.
HEWITT-ROBINS, INC.
INGERSOLL-RAND CO.
Joy Mfg. Co.
Lidgerwood Industries, Inc.
Marion Power Shovel Co.
O. K. Machinery Div. John C. Motter Printing Press Co.
Rockwell Spring & Axle Co. Timken-Detroit Axle Div.
SAUERMAN BROS., INC.
Vulcan Iron Works Co., (Denver)

HOISTS, LIFT, HAND CHAIN & RATCHET

American Chain & Cable Co., Inc. Wright Hoist Div.
Chisholm-Moore Hoist Div. Columbus McKinnon Chain Corp.
Chester Hoist Div. National Screw Mfg. Co.
Coffing Hoist Div. Duff-Norton Co.
Conco Engineering Works
DENVER EQUIPMENT CO.
Duff Norton Co.
Forker Corp.
Graybar Elec. Co., Inc.
Hales Co., W. M.
Harrington Co.
Manning, Maxwell & Moore, Inc. Shaw Box Crane & Hoist Div.
Reading Crane & Hoist Corp.
Robbins & Meyers, Inc., Hoist & Crane Div.
Round & Son, Inc., David
Ryerson & Son, Inc., Joseph T.
Yale & Towne Mfg. Co. Yale Materials Handling Div.

HOISTS, LIFT, SHOP TYPE, PORTABLE & MOVABLE —does not include Hoists, Lift, Hand Chain

American Chain & Cable Co., Inc. Wright Hoist Div.
American Pulley Co.
Chester Hoist Div., National Screw Mfg. Co.
Chicago Pneumatic Tool Co.
Clyde Iron Works, Inc.
Coffing Hoist Div. Duff-Norton Co.
Conco Engineering Works
Construction Machy. Co.
DENVER EQUIPMENT CO.
Detroit Hoist & Machine Co.
Duff-Norton Co.
Electro Lift, Inc.
Forker Corp.
GARDNER-DENVER CO.
Gripholst, Inc.
Harrington Co.
HEWITT-ROBINS, INC.
Hyster Co.
INGERSOLL-RAND CO.
Joy Mfg. Co.
Lidgerwood Industries, Inc.
Manning, Maxwell & Moore, Inc. Shaw Box Crane & Hoist Div.
O. K. Machinery Div. John C. Motter Printing Press Co.
Princeton Gripholst, Inc.
Reading Crane & Hoist Corp.
Round & Son, Inc., David
Ryerson & Son, Inc., Joseph T.
Silent Hoist & Crane Corp.
Templeton, Kenly & Co.
Thor Power Tool Co.
Yale & Towne Mfg. Co. Yale Materials Handling Div.

HOISTS, LIFT, SHOP TYPE, STATIONARY

American Hoist & Derrick Co.
Anthony Co.
Atlas Copco Pacific, Inc.
Bartlett & Snow Co., C. O.
Clyde Iron Works, Inc.
Conco Engineering Works
Curtis Manufacturing Co.
Electro Lift, Inc.
GARDNER-DENVER CO.
Harrington Co.
HEWITT-ROBINS, INC.
INGERSOLL-RAND CO.
Joy Mfg. Co.
Joyce-Cridland Co.
Lidgerwood Industries, Inc.
Manning, Maxwell & Moore, Inc. Shaw Box Crane & Hoist Div.
NATIONAL IRON CO.
Nowo Pump & Engine Co.
Reading Crane & Hoist Corp.
Round & Son, Inc., David
Ryerson & Son, Inc., Joseph T.
SAUERMAN BROS. INC.
Shepard Niles Crane & Hoist Corp.
Silent Hoist & Crane Corp.
Superior-Lidgerwood-Mundy Corp.

HOISTS, MINE SHAFT DRUM — does not include: Sheaves; Skips & Cages; Buckets

Clyde Iron Works, Inc.
GARDNER-DENVER CO.
HEWITT-ROBINS, INC.
Hirsch Bros. Machy. Co.
Holmes & Bros., Inc. Robert
INGERSOLL-RAND CO.
Joy Mfg. Co.
Lake Shore, Inc. Lake Shore Engineering Div.
Lidgerwood Industries, Inc.
Manning, Maxwell & Moore, Inc. Shaw Box Crane & Hoist Div.
NORDBERG MFG. CO.
Rogers Iron Works Co.
Shepard Niles Crane & Hoist Corp.
STEARNS ROGER MFG. CO.
Superior-Lidgerwood-Mundy Corp.
Vulcan Iron Works Co., (Denver)
VULCAN IRON WORKS

HOISTS, MINE SHAFT FRICTION—does not include: Sheaves, Skips & Cages; Buckets

ASEA ELECTRIC INC.
Clyde Iron Works, Inc.
CONNELLSVILLE MFG. & MINE SUPPLY CO.
Lidgerwood Industries, Inc.
Manning, Maxwell & Moore, Inc. Shaw Box Crane & Hoist Div.
MAYO TUNNEL & MINE EQUIPMENT
NORDBERG MFG. CO.
Superior-Lidgerwood-Mundy Corp.

HOIST CONTROLS & ACCESSORIES, MINE SHAFT — also see Controls

LOGAN ENGINEERING CO.

(HOISTS, TUGGER — see Winches)

HOSE, AIR, STEAM, WATER, ET AL

Acme Rubber Mfg. Co.
Aeroquip Corp.
Aeroquip Corp. Western Div.
American Brass Co.
American Hard Rubber Co.
American Rubber Mfg. Co.
Arrowhead Products Div. Federal-Mogul-Bower Bearings Inc.
Atlas Copco Pacific, Inc.
Binks Mfg. Co.
Boston Woven Hose & Rubber Co.
Branford Co.
Carlyle Rubber Co.
Chicago Pneumatic Tool Co.
Cincinnati Rubber Mfg. Co. Div. Thor Power Tool Co.
Continental Rubber Works
Drilling Accessory & Mfg. Co., Inc.
Eastman-Pacific Co.
EIMCO CORP.
Flexaust Co.
Fyr-Fyter Co.
Gates Rubber Co.
Gering Products, Inc.
Goodall Rubber Co.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co. Industrial Products
Hamilton Rubber Mfg. Corp.
HEWITT-ROBINS, INC.
Industrial Air Products Co.
Johnson Corp.
Lincoln Engineering Co. Div. McNeil Machine & Engineering Co.
New York Belting & Packing Co.
Pangborn Corp.
Pickard Industries, Inc., Central Mine Supply Co., Div.
Quaker Rubber Div. H. K. Porter Company, Inc.
Raybestos-Manhattan, Inc. Manhattan Rubber Div.
Republic Rubber Div. Lee Rubber & Tire Corp.
Snyder & Son, Inc., M. L.

Stewart-Warner Corp. Alemite Div.
Stratoflex, Inc.
Thermoid Co. Industrial Div.
Thor Power Tool Co.
Titeflex, Inc.
U. S. Rubber Co.
U. S. Rubber Co. Mechanical Goods Div.
Weatherhead Co. Fort Wayne Div.

HOSE FITTINGS — CLAMPS, COUPLINGS, SWIVEL JOINTS, ETC.

Aeroquip Corp.
Aeroquip Corp. Western Div.
American Rubber Mfg. Co.
Arrowhead Products Div. Federal-Mogul-Bower, Bearings Inc.
Atlas Copco Pacific, Inc.
Band-It Co.
Binks Mfg. Co.
Boston Woven Hose & Rubber Co.
Branford Co.
Carlyle Rubber Co.
Chicago Pneumatic Tool Co.
Chiksan Co.
Continental Rubber Works
Crane Co.
Dixon Valve & Coupling Co.
Drilling Accessory & Mfg. Co., Inc.
Eastman Mfg. Co.
Eastman-Pacific Co.
Eaton Mfg. Co.
Fyr-Fyter Co.
Gates Rubber Co.
Goodall Rubber Co.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co. Industrial Products
HEWITT-ROBINS, INC.
Hunt & Son, Inc., C. B.
Jordan Corp., Div. OPW Corp.
LE-HI Div. Hose Accessories Co.
Lincoln Engineering Co. Div. McNeil Machine & Engineering Co.
Lunkenheimer Co.
Meckum Engineering, Inc.
Quaker Rubber Div. H. K. Porter Company, Inc.
Raybestos-Manhattan, Inc. Manhattan Rubber Div.
Snyder & Son, Inc., M. L.
Stewart-Warner Corp. Alemite Div.
Stratoflex, Inc.
Thor Power Tool Co.
U. S. Rubber Co.
Weatherhead Co. Fort Wayne Div.

HUBS, AUTO WHEEL, SELECTIVE DRIVE

International Harvester Co.
Rockwell Spring & Axle Co. Timken-Detroit Axle Div.
WARN MFG. CO.

(HYDRAULIC CYLINDERS—see Cylinders, Air & Hydraulic)

(HYDRAULIC MONITOR — see Monitors)

HYDRAULIC MOTORS

Commercial Shearing & Stamping Co. Dept. EMJ-MG
LINK-BELT CO.
Oilgear Co.
Rockwell Mfg. Co.
Vickers Inc. Administrative & Engineering Center

(HYDRAULIC PUMPS — see Pumps, Hydraulic Fluid)

(HYDRAULIC RAMS — see Pumps, Hydraulic Ram)

(HYDROMETER—see Meters, Liquid Density)

I

(INSTRUMENTS—see: Drafting Equipment; Geophysical Instruments; Chemical Laboratory Equipment; Laboratory & Scientific Instruments, Equipment & Supplies; Meters; Surveying Equipment)

INSULATING MATERIALS, ELECTRICAL

American Lava Corp.
Anderson Mfg. Co., Albert & J. M.
Brady Co., W. H.
Continental-Diamond Fibre Corp. A Subsidiary of Budd Co.
Corning Glass Works
Dow Corning Corp.
DuPont de Nemours & Co., Inc. E. I. Fabrics Div.
Duquesne Mine Supply Co.
G. & W. Electric Specialty Co.
Graybar Elec. Co., Inc.
Irvington Div. Minnesota Mining & Mfg. Co.
Johns-Manville
Keasbey & Mattison Co.
Mica Insulator Div., Minnesota Mining & Mfg. Co.
National Vulcanized Fibre Co.
Phelps Dodge Copper Products Corp.
Plymouth Rubber Co.
Punch-Lok Co.
Quaker Rubber Div. H. K. Porter Co., Inc.
Ruberoid Co.
Sauereisen Cement Co.
Synthane Corp.
Taylor Fibre Co.
Thiokol Chemical Corp.
U. S. Rubber Co.
West Virginia Pulp & Paper Co.
Westinghouse Electric Corp.
Zophar Mills, Inc.

INSULATING MATERIALS, MOISTURE & GAS

Bemis Bro. Bag Co.
Corning Glass Works
Johns-Manville
Zophar Mills, Inc.

INSULATING MATERIALS, SOUND

Carey Mfg. Co., Philip
Corning Glass Works
Eagle-Picher Co.
Gustin-Bacon Mfg. Co.
HEWITT-ROBINS, INC.
Johns-Manville
Keasbey & Mattison Co.
Laubenstein Mfg. Co.
Pacific Lumber Co.
U. S. Rubber Co.

INSULATING MATERIALS, THERMAL, BLOCK & BOARD—also see Refractories

Bigelow-Liptak Corp.
Carey Mfg. Co., Philip
Dow Chemical Co.
Eagle-Picher Co.
General Refractories, Co.
Johns-Manville
Keasbey & Mattison Co.
Mexico Refractories Co.
Mullite Works Refractories Div. H. K. Porter Company, Inc.
Pittsburg-Corning Corp.
Quigley Co. Inc.
Refractory & Insulation Corp.
Robinson Clay Product Co.
Ruberoid Co.

INSULATING MATERIALS, THERMAL, BULK—also see Refractories

BABCOCK & WILCOX CO.
Bigelow-Liptak Corp.
Carey Mfg. Co., Philip
Eagle-Picher Co.
General Refractories, Co.
Green Fire Brick Co., A. P.
Gustin-Bacon Mfg. Co.
Ironton Fire Brick Co.
Johns-Manville
Keasbey & Mattison Co.
Laclede-Christy Works, Refractories Div., H. K. Porter Co., Inc.
Mexico Refractories Co.
Mullite Works Refractories Div. H. K. Porter Company, Inc.
Norton Co.
Pacific Lumber Co.
Pettinos Inc., George F.
Pittsburg-Corning Corp.
Quigley Co., Inc.
Refractory & Insulation Corp.
Robinson Clay Product Co.

INSULATING MATERIALS, THERMAL, CASTABLE & CEMENT COMPOUNDS—also see Refractories

BABCOCK & WILCOX CO.
Bigelow-Liptak Corp.
Carey Mfg. Co., Philip
Corhart Corp.
Dow Corning Corp.
Eagle-Picher Co.
HEWITT-ROBINS, INC.
Ironton Fire Brick Co.
Johns-Manville
Laclede-Christy Works, Refractories Div., H. K. Porter Co., Inc.
Mexico Refractories Co.
Mullite Works Refractories Div. H. K. Porter Company, Inc.
Norton Co.
Quigley Co., Inc.
Refractory & Insulation Corp.
Robinson Clay Product Co.
Sauereisen Cement Co.

INSULATING MATERIALS, THERMAL, CLOTH & PAPER

Carey Mfg. Co., Philip
Gatke Corp.
Johns-Manville
Keasbey & Mattison Co.
Ruberoid Co.
Union Asbestos & Rubber Co.

ION EXCHANGE EQUIPMENT (SPECIAL) — does not include standard auxiliary equipment; also see Water Clarification

Allis-Chalmers Mfg. Co. Industries Group
American Water Softener Co.
Brosites Products Corp.
Cochrane Corp.
Dorr-Oliver, Inc.
Enley Products, Inc.
Graver Water Conditioning Co.
Hagan Chemicals & Controls, Inc. Divisions: Calgon Co., Hall Laboratories
Infilco, Inc.
Ionics, Inc.
Permutit Co., Div. Pfaudler Permutit Inc.
Turbo-Mixer Div. General American Transportation Corp.
WESTERN MACHINERY CO.

ION EXCHANGE RESINS

Allis-Chalmers Mfg. Co. Industries Group
American Water Softener Co.
Chemical Process Co.
Cochrane Corp.
Dow Chemical Co.
Enley Products, Inc.
Graver Water Conditioning Co.
Hagan Chemicals & Controls, Inc. Divisions: Calgon Co., Hall Laboratories
Permutit Co. Div. Pfaudler Permutit Inc.
Rohm & Haas Co.
Van Waters & Rogers, Inc.

J

JACKS, LIFTING, (SCREW, HYDRAULIC, ETC.)—also see: Hoists; Jacks, Roof

Badger Malleable & Mfg. Co.
Blackhawk Mfg. Co.
Clark Controller Co.
Duff Norton Co.
Foster Co., L. B.
Frank, M. K.
Gibraltar Equipment & Mfg. Co.
Illinois Iron & Bolt Co.
Ionics, Inc.
Joyce-Cridland Co.
Moran Engineering Co.
Owatonna Tool Co.
Star Jack Co.
Swett Iron Works, A. L.
Templeton, Kenly & Co.

(JACKS, PULLING — see Hoists)

JACKS, ROOF—also see Mine Supports, Re-usable Props

Duff Norton Co.
Foster Co., L. B.
Hales Co., W. M.
Harold Mfg. Co.
Joyce-Cridland Co.
Star Jack Co.
Templeton, Kenly & Co.

(JIGS—see Separators, Jig)

K

(KILNS, ROASTERS & DRYERS—see below; also see: Dryers, Furnaces; Retorts; Sintering Equipment)

KILNS, ROASTERS & DRYERS, BEEHIVE, TUNNEL & SINGLE HEARTH (STATIONARY & MOVING)

Allis-Chalmers Mfg. Co. Industries Group
Bigelow-Liptak Corp.
Charcoal Corp. of America
Dorr-Oliver, Inc.
Harper Electric Furnace Corp.
Hyi-Duty Electric Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Kirk & Blum Mfg. Co.
STEARNS ROGER MFG. CO.

KILNS, ROASTERS & DRYERS, ROTARY

Allis-Chalmers Mfg. Co. Industries Group
Bartlett & Snow Co., C. O.
Canadian Locomotive Co., Ltd.
CARPCO MANUFACTURING, INC.
DIESEL ENERGY CORP.
General American Transportation Corp.
General American Transportation Corp. Louisville Dryer Div.
GOULD CO., GORDON I.
Hack Engineering Co.
HARDINGE CO., INC.
Heineken, Inc. W. P.
Kennedy-Van Saun Mfg. & Eng. Corp.
MACHINERY CENTER INC.
McNally Pittsburg Mfg. Corp.
MINE & SMELTER SUPPLY CO., MFG. DIV.
NORDBERG MFG. CO.
Ogden Iron Works
Salem-Brosius, Inc.
SMIDTH & CO., F. L.
Standard Steel Corp.
STEARNS ROGER MFG. CO.
Stroh Process Steel Co.
TRAYLOR ENGINEERING & MFG. CO.
VULCAN IRON WORKS
Washington Machinery Co.
Yuba Consolidated Industries, Inc.

(KILNS, ROASTERS & DRYERS, SHAFT—see Furnaces, Shaft)

KILNS, ROASTERS & DRYERS, MULTIPLE-HEARTH (MECHANICAL RABBLE) TOWER

Allis-Chalmers Mfg. Co. Industries Group
Dorr-Oliver, Inc.
MINE & SMELTER SUPPLY CO., MFG. DIV.
NICHOLS ENGINEERING & RESEARCH CORP.
Pacific Foundry Co., Ltd.
STEARNS ROGER MFG. CO.

KILN (& INDUSTRIAL) GUNS (DECLOGGING)—does not include Refractory Placers

Remington Arms Co., Inc.

L

LABORATORY & SCIENTIFIC INSTRUMENTS, EQUIPMENT & SUPPLIES other than Chemical Lab.

Equip., Geophysical Instruments, Drafting Equipment, Surveying Equipment—also see Meters

American Instrument Co., Inc.
American Paulin System
Assembly Products, Inc.
Baker & Adamson Products, General Chemical Div., Allied Chemical Corp.
Bartlett & Snow Co., C. O.
Bausch & Lomb Optical Co.
Beckman Instruments, Inc.
Bico, Inc.
Blue M Electric Co.
Booth Co.
Cargille Laboratories, Inc. R. P.
CARPCO MANUFACTURING, INC.
Central Scientific Co.
Consolidated Electrodynamics Corp.
Coors Porcelain Co.
Corning Glass Works
Curtiss-Wright Corp. Electronics Div.
DENVER EQUIPMENT CO.
Engelhard Industries Inc.
Fahrenwald Co., A. W.
Fischer & Porter Co.
Fisher Scientific Co.
Gallgher Co.
Gray Instrument Co.
Hagan Chemicals & Controls, Inc. Divisions: Calgon Co., Hall Laboratories
Holmes & Bros., Inc. Robert
Jarrell-Ash Co.
Knopp, Inc.
Ledoux & Co.
Leeds & Northrup Co.
Mallinckrodt Chemical Works
Mead Mill Co.
Metals Disintegrating Co. Inc. Pulverizing Machinery Div.
MINE & SMELTER SUPPLY CO., MFG. DIV.
Minneapolis-Honeywell Regulator Co.
Mixing Equipment Co.
Morse Bros. Machinery Co.
Mt. Sopris Instrument Co.
Norton Co.
Perkin Engineering Co.
Pettinos, Inc., George F.
Philips Electronics, Inc. Instruments Div.
Radiation Counter Laboratories, Inc.
Sharples Corp.
Snyder & Son, Inc., M. L.
Southwestern Industrial Electronics Co.
Sturtevant Mill Co.
Torsion Balance Co.
Turbo-Mixer Div. General American Transportation Corp.
Ultra-Violet Products, Inc.
Universal Vibrating Screen Co.
Voland & Sons, Inc.
Van Waters & Rogers, Inc.
WESTERN MACHINERY CO.

LABORATORY SERVICE, CHEMICAL ANALYZING & ASSAYING

American Spectrographic Laboratories, Inc.
Arizona Assay Office.
Booth Co.
California Testing Laboratories, Inc.
CARPCO MANUFACTURING, INC.
Chapman, Wood & Griswold
Chemalco Inc.
Commercial Testing & Engrg. Co.
Custom Assay Office
Dearon & Nichols
DENVER EQUIPMENT CO.
Dickinson Laboratories, Inc.
El Paso Testing Laboratories
Geophysical Instrument & Supply Co.
Goodall Brothers
Hagan Chemicals & Controls, Inc. Divisions: Calgon Co., Hall Laboratories
Hanks, Inc., Abbot A.
Hawley & Hawley, Assayers & Chemists, Inc.
Hill & Jude, Assayers
Jarrell-Ash Co.
Ledoux & Co.
McDowell Co., Inc.
Pitkin, Inc., Lucius
Smith-Emery Co.
Snell, Inc., Foster D.
Spectrochemical Laboratories, Inc.
Stowell & Co., W. H.
Taller & Cooper Inc.
Tour & Co., Sam
Tracerlab, Inc.
Ultra-Violet Products, Inc.
U. S. Testing Co., Inc.
Walker & White, Inc.
WESTERN MACHINERY CO.
Wood Assaying Co., Henry E.

LABORATORY SERVICE, MINERAL DETERMINATION

CARPCO MFG., INC.
MOBILE DRILLING & ENGINEERING INC., DIV. MOBILE DRILLING, INC.
Pitkin, Inc., Lucius

LABORATORY SERVICE, TESTING other than chemical & mineral above—also see: Consultants; Contractors

Pitkin, Inc., Lucius

(LARRIES—see: Cars; Mine; Skips & Cages; Trailers & Wagons)

LIGHTING FIXTURES & LAMPS, INDUSTRIAL (ELECTRIC)—also see Flood Lights

Appleton Electric Co.
Circle F Mfg. Co.
Concordia Electric Co.
Crouse Hinds Co.
Femco, Inc.
Guyan Machy. Co.
Line Material Industries McGraw-Edison Co.
Multi Electrical Mfg. Co.
Phenix Products Co.
Pittsburgh Reflector Co.
Pyle-National Co.
Ray-O-Vac Co.
Steber Mfg. Co.
Sylvania Electric Products, Inc.
Westinghouse Electric Corp.

(LININGS & CLADDINGS—see below; also see: Furnace Linings; Insulating Materials Steel, Alloy; Tanks, Lined; does not include Coatings)

(LININGS, ABRASION RESISTANT, METALLIC — see: Hardfacing; Metalizing; Steel, Alloy)

LININGS & CLADDINGS, ABRASION, RESISTANT, NON-METALLIC

Acme Rubber Mfg. Co.
Amerccat Corp.
Bigelow-Liptak Corp.
Bonded Scale & Machine Co.
Carboline Co.
Carey Mfg. Co., Philip
DENVER EQUIPMENT CO.
DuPont de Nemours & Co., Inc., E. I. Fabrics Div.
Gallgher Co.
Garlock Packing Co.
Gates Engr. Co.
Grodall Rubber Co.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co.
Green Fire Brick Co., A. P.
Hamilton Rubber Mfg. Corp.
Haynes Stellite Co. Div. Union Carbide Corp.
Irontrn Fire Brick Co.
LINATEX CORP. OF AMERICA
Mexico Refractories Co.
New York Belting & Packing Co.
Norton Co.
Patterson Foundry & Machine Co.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Pipe Linings, A Div. of American Pipe & Construction Co.
Quaker Rubber Div. H. K. Porter Co., Inc.
Quigley Co., Inc.
Raybestos-Manhattan, Inc. Manhattan Rubber Div.
Republic Rubber Div. Lee Rubber & Tire Corp.
Sauereisen Cement Co.
Thomas Foundries, Inc.
U. S. Rubber Co.
U. S. Rubber Co. Mechanical Goods Div.
Yuba Consolidated Industries, Inc., Yuba Mining Div.

LININGS & CLADDINGS, CORROSION - RESISTANT METALLIC—Steel, Alloy; Tanks, Lined

Alco Products, Inc.
Aluminum Co. of America
Amerccat Corp.
American Brake Shoe Co. American Manganese Steel Div.
Ampco Metal, Inc.
Atlas Steels, Ltd.
BABCOCK & WILCOX CO.
Carboline Co.
CRUCIBLE STEEL CO. OF AMERICA
DENVER EQUIPMENT CO.
Gallgher Co.
Haynes Stellite Co. Div. Union Carbide Corp.
Irwin Foundry & Mine Car Co.
Klemp Metal Grating Corp.
Reilly Tar and Chemical Corp.

LININGS & CLADDINGS, CORROSION - RESISTANT, NON-METALLIC — also see: Tanks, Lined

Acme Rubber Mfg. Co.
American Hard Rubber Co.
Bigelow-Liptak Corp.
Carboline Co.
DENVER EQUIPMENT CO.
DuPont de Nemours & Co., Inc., E. I. Fabrics Div.
Formica Corp. Subsidiary of Cyanamid
Gallgher Co.
Garlock Packing Co.
Gates Engrg. Co.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co. Industrial Products
Goodyear Tire & Rubber Co.
Hamilton Rubber Mfg. Corp.
LINATEX CORP. OF AMERICA
Luzerne Rubber Co.
Metal & Thermit Corp.
National Carbon Co. Union Carbide Corp.
Norton Co.
Patterson Foundry & Machine Co.
Pennsalt Chemicals Corp.
Permagile Corp. of America
Quaker Rubber Div. H. K. Porter Company, Inc.
Quigley Co., Inc.
Raybestos-Manhattan, Inc. Manhattan Rubber Div.
Ryerson & Son, Inc., Joseph T.
Sauereisen Cement Co.
U. S. Rubber Co.
U. S. Rubber Co. Mechanical Goods Div.
Wilbur & Williams Co.

(LOADERS—see below; also see: Conveyors; Dredges; Excavators; Scrapers; Trucks & Trailers Self-Loading)

LOADERS, BOXCAR

Hrugh Co., Frank G.
Lippmann Engineering Works, Inc.
LINK-BELT CO.
McNally Pittsburg Mfg. Corp.
Ottumwa Box Car Loader Co.
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.

LOADERS, SELF-LOADING CONVEYOR, (CHAIN, BELT, BUCKET-LINE, ETC.) WITH DIGGING COMPONENT—does not include: Excavators; Bucket-wheel; or Conveyor alone. Also, see: Loaders, Gathering-Head, Mine-Type

Athey Products Corp.
Barber-Greene Co.
Bonded Scale & Machine Co.
Butler Bin Co.
Chain Belt Co.
Christian Engineers, J. D.
Erie Strayer Co.
Gibraltar Equipment & Mfg. Co.
Goodman Mfg. Co.
Hack Engineering Co.
Herold Mfg. Co.
HEWITT-ROBINS, INC.
Heyl & Patterson, Inc.
Irwin Foundry & Mine Car Co.
LE TOURNEAU-WESTINGHOUSE CO.
LINK-BELT CO.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
Universal Dredge Mfg. Co.
Washington Machinery Co.

LOADERS, FRONT-END SCOOP, CRAWLER-TRACTOR — does not include overcast type

Allis-Chalmers Mfg. Co. Construction Machinery Div.
Atco Div. Greenville Steel Car Co.
Case Co., J. I. Industrial Div.
Caterpillar Tractor Co.
Drott Mfg. Co.
EIMCO CORP.
Hough Co., Frank G.
Hyster Co.
International Harvester Export Co.
Link-Belt Speeder Corp.
MACHINERY CENTER, INC.
Myers-Whaley Co., Inc.
Oliver Corp.
Sanford-Day Iron Works, Inc.
Thew Shovel Co.
TRACTOMOTIVE CORP.

LOADERS, FRONT-END SCOOP, WHEELED TRACTOR — does not include overcast type

Allis Chalmers Mfg. Co., Construction Machinery Div.
Case Co., J. I. Industrial Div.
Clark Equipment Co. Construction Machinery Div.
Deere Co., John
Hough Co., Frank G.
Hyster Co.
International Harvester Export Co.
Myers-Whaley Co., Inc.
Oliver Corp.
Pettibone Mulliken Corp.
Sanford-Day Iron Works, Inc.
Schramm, Inc.
Thew Shovel Co.
TRACTOMOTIVE CORP.

LOADERS, GATHERING-HEAD, MINE-TYPE—also see: Loaders, Self-loading Conveyor

GARDNER DENVER CO.
Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Long Co.

LOADERS, OVERCASTING BUCKET, MINE-TYPE, CRAWLER, RAIL & WHEELED

EIMCO CORP.
Atlas Copco
GARDNER-DENVER CO.
Joy Mfg. Co.
MACHINERY CENTER, INC.

LOADERS, OVERDUMPING SCOOP & ROLLING BUCKET, SURFACE-TYPE

LOADERS, SCRAPER-SLUSHER MOVABLE RAMP

Rogers Iron Works Co.

LOADERS, SPECIAL MINE SHAFT MUCKING

Blaw Knox Co.
Boland Development Co. Ltd.
Bucyrus-Erie Co.
EIMCO CORP.
GARDNER-DENVER CO.
Joy Mfg. Co.
MACHINERY CENTER INC.
Riddell, J. Murray
Ruhr Industries
Sanford-Day Iron Works, Inc.
Shaft Development Machines, Inc.
Sturrock & Co. Ltd.

LOADERS, SPECIAL TUNNEL MUCKING—also see: Trucks & Trailers, Special Self-Loading

EIMCO CORP.

LOADING ATTACHMENTS, SPECIAL FOR SELF-LOAD-

ING VEHICLES

EIMCO CORP.

(LOADING BOOMS — see: Conveyors; Cranes)

LOCOMOTIVES, COMPRESSED AIR

EIMCO CORP.
Hack Engineering Co.
MACHINERY CENTER INC.
MAYO TUNNEL & MINE EQUIPMENT
Universal Dredge Mfg. Co.

LOCOMOTIVES, ELECTRIC BATTERY & TROLLEY

Atlas Car & Mfg. Co.
Easton Car & Construction Co.
Frank, M. K.
General Electric Co. Apparatus Sales Div.
Greensburg Machine Co.
Ironton Engine Co.
Jeffrey Mfg. Co.
Kersey Mfg. Co., Inc.
MACHINERY CENTER INC.
Mancha Storage Battery Locomotive Div. Goodman Mfg. Co.
Moran Engineering Co.
National Mine Service Co.
Universal Dredge Mfg. Co.
West Virginia Armature Co.

LOCOMOTIVES, GASOLINE, DIESEL & DIESEL-ELECTRIC

Alco Products, Inc.
Atlas Car & Mfg. Co.
Brockville Locomotive Works
Canadian Locomotive Co., Ltd.
DIESEL ENERGY CORP.
Differential Steel Car Co.
Fairbanks, Morse & Co.
Frank, M. K.
General Electric Co. Apparatus Sales Div.
General Motors Corp. Electro-Motive Div.
Hack Engineering Co.
International Harvester Export Co.
Mancha Storage Battery Locomotive Div. Goodman Mfg. Co.
MAYO TUNNEL & MINE EQUIPMENT
Minerals Engineering Co.
National Mine Service Co.
PLYMOUTH LOCOMOTIVE WORKS DIV. FATE, ROOT-HEATH CO.
ROGERS BROTHERS CORP.
Ruth Co.
Telluride Iron Works Co.
Westinghouse Air Brake Co.

LOCOMOTIVES, STEAM

Frank, M. K.

(LOG WASHERS — see Scrubbers)

LUBRICANTS

Alpha Molykote Corp.
American Oil Co.
Arkansas Fuel Oil Corp.
Atlantic Refining Co.
Borne Chemical Co., Inc.
Brooks Oil Co.
Cabot, Inc., Samuel
Cities Services Oil Co.
Climax Molybdenum Co.
Dixon Crucible Co., Joseph
Dow Corning Corp.
Esso Standard Oil Co. National & Comm. Sales Div.
Felt Products Mfg. Co.
Gulf Oil Corp.
Hales Co., W. M.
Houghton & Co., E. F.
Hulburt Oil & Grease Co.
Imperial Oil & Grease
Jesco Lubricants Co.
Jet-Lube, Inc.
Keystone Lubricating Co.
Leschen Wire Rope Div. H. K. Porter Company, Inc.
Lockrey Co.
Lubriplate Div. Fiske Bros. Refining Co.
New York & New Jersey Lubricant Co.
Ohio Grease Co.
Ohio Oil Co.
Pettinos, Inc., George F.
Phillips Petroleum Co.
Pure Oil Co.
Shell Oil Co.
Sinclair Refining Co.
Socony Mobil Oil Co.
STANDARD OIL CO., OF CALIFORNIA WESTERN OPERATIONS, INC.
Standard Oil Co.—Indiana
Stewart-Warner Corp. Alemite Div.
Sun Oil Co.
TEXAS CO.
Union Carbide Chemicals Co. Union Carbide Corp.
Valvoline Oil Co. Div. Ashland Oil & Refining Co.
Whitmore Mfg. Co.

LUBRICATING EQUIPMENT

Farval Corp.
Frantz Co., Inc. S. G.
Gray & Co., Inc.
Hales Co., W. M.
Lincoln Engineering Co. Div. McNeil Machine & Engineering Co.
Lunkenheimer Co.
Manzel Div. Houdaille Industries, Inc.
Powell Co., Wm.
Stewart-Warner Corp. Alemite Div.
Thor Power Tool Co.
Trico Fuse Mfg. Co.
Wilkerson Corp.

M

MAGNETS—also see Separators, Magnetic

CARPCO MANUFACTURING, INC.
CRUCIBLE STEEL CO. OF AMERICA
Cutler-Hammer, Inc.
Dings Magnetic Separator Co.
Electric Controller & Mfg. Co. Div. Square D. Co.
Eriez Mfg. Co.
Homer Mfg. Co.
Magnetic Engineering & Mfg. Co.
Metallurgical Products Dept. General Electric Co.
Shrader Co., F. W.
Stackpole Carbon Co.
STEARNS MAGNETIC PRODUCTS

MAPS, GEOGRAPHIC — does not include Contractors, Mapping

AERO SERVICE CORP.
Aero Service Corp. de Venezuela C. A.
African Surveys (Pty.) Ltd.
Ammann Photogrammetric Engineers, Inc. Jack
Canadian Aero Service Ltd.
Spartan Air Services

METALLIZING EQUIPMENT

Consolidated Electrodynamics Corp.
Metallizing Engineering Co., Inc.

METALLIZING SUPPLIES — also see Welding Supplies

American Chain & Cable Co., Inc. Page Steel & Wire Div.
CRUCIBLE STEEL CO. OF AMERICA
Hales Co., W. M.
Metallizing Engineering Co., Inc.
Vanadium-Alloys Steel Co.

METERS & GAGES, INDICATING & MEASURING DEVICES & INSTRUMENTS (REMOTE, RECORDING, ETC.)—see below; also see: Bin-Level Indicators; Communications; Controls; Drafting Instruments; Gas (& Moisture) Detectors; Geophysical Instruments; Chemical Laboratory Equipment; Laboratory & Scientific Instruments; Scales; Surveying Instruments; Spectroscopic Instruments

ABCs Scale Div. McDowell Co., Inc.
American Instrument Co., Inc.
Auto-Lite Battery Corp.
Bailey Meter Co.
Beckman Instruments, Inc. Berkeley Div.
Bristol Co.
Builders-Providence Div. B-I-F Industries
Chatillon & Sons, John
Consolidated Electrodynamics Corp.
Curtiss-Wright Corp. Electronics Div.
Differential Steel Car Co.
El-Tronics, Inc.
Engelhard Industries Inc.
Fischer & Porter Co.
Fisher Research Laboratory, Inc.
Fisher Scientific Co.
Foxboro Co.
General Electric Co. Apparatus Sales Div.
General Equipment & Mfg. Co.
Gray Instrument Co.
Hagan Chemicals & Controls, Inc. Divisions: Calgon Co., Hall Laboratories
Illinois Testing Laboratories, Inc.
INDUSTRIAL PHYSICS & ELECTRONICS CO.
Isotope Products, Inc. Instrument Div.
Leeds & Northrup Co.
Lonergan Co., J. E.
Lufkin Rule Co.
Meriam Instrument Co.
MINE SAFETY APPLIANCES CO.
Minneapolis-Honeywell Regulator Co.
Minneapolis-Honeywell Regulator Co. Brown Instrument Div.
Minneapolis-Honeywell Regulator Co. Industrial Div.
New Jersey Meter Co.
Newage Industries, Inc.
Norden-Ketay Corp.
Nuclear Research Corp.
Penberthy Mfg. Co.
Radiation Counter Laboratories
Rawson Electrical Instrument Co.
Republic Flow Meters Co.
Rockwell Mfg. Co.
Schroeder Brothers
Southwestern Industrial Electronics Co.
SPRENGNETHER INSTRUMENT CO., INC., W. F.
Texas Instruments, Inc. Industrial Instrumentation Div.
Tracerlab, Inc.
Uehling Instrument Co.
U. S. Gauge Div. American Machine & Metals, Inc.
Universal Atomics Div. Universal Transistor Products Corp.
Vapor Recovery Systems Co.
Weston Instruments, Div. Daystrom, Inc.
Yarnall-Waring Co.

METERS & GAGES, ETC., CHEMICAL (pH POLAROGRAPH, ETC.)

Analytical Measurements, Inc.
Bailey Meter Co.
Beckman Instruments, Inc. Process Instruments Div.
Bristol Co.
Central Scientific Co.
Consolidated Electrodynamics Corp.
Curtiss-Wright Corp. Electronics Div.
Fisher Scientific Co.
Foxboro Co.
INDUSTRIAL PHYSICS & ELECTRONICS CO.
Jarrell-Ash Co.
Leeds & Northrup Co.
Macbeth Daylighting Corp.
Minneapolis-Honeywell Regulator Co.
Minneapolis-Honeywell Regulator Co. Brown Instrument Div.
Minneapolis-Honeywell Regulator Co. Industrial Div.
Taylor & Co., W. A.
Uehling Instrument Co.

METERS & GAGES, ETC., COUNTING

Beckman Instruments, Inc.
Bristol Co.
Curtiss-Wright Corp. Electronics Div.
Electro Products Laboratories
Fischer & Porter Co.
Nuclear Research Corp.
Rockwell Mfg. Co.
Tracerlab, Inc.
Uehling Instrument Co.
Van Waters & Rogers, Inc.

METERS & GAGES, ETC., ELECTRICITY (AMMETERS, VOLTMETERS, ET AL)

AMERICAN CYANAMID CO., EXPLOSIVES & MINING CHEMICALS DEPT.
Assembly Products, Inc.
Auto-Lite Battery Corp.
Beckman Instruments, Inc.
Bristol Co.
Columbia Electric Mfg. Co.
Consolidated Electrodynamics Corp.
Curtiss-Wright Corp. Electronics Div.
DuPont de Nemours & Co., E. I.
Engelhard Industries Inc.
Esterline-Angus Co., Inc.
General Electric Co. Apparatus Sales Div.
Graybar Elec. Co., Inc.
HERCULES POWDER CO.
Knopp, Inc.
Minneapolis-Honeywell Regulator Co. Brown Instrument Div.
Sangamo Electric Co.
Southwestern Industrial Electronics Co.
Stewart-Warner Corp. Alemite Div.
Texas Instruments, Inc. Industrial Instrumentation Div.
Uehling Instrument Co.
U. S. Guage Div., American Machine & Metal, Inc.
Westinghouse Electric Corp.
Weston Electrical Instrument Corp. Subsidiary of Daystrom, Inc.

METERS & GAGES, ETC., FLUID (FLOW, PRESSURE & VACUUM)

American Chain & Cable Co., Inc. Helicoid Gage Div.
American Paulin System
Auto-Lite Battery Corp.
Bailey Meter Co.
Beckman Instruments, Inc.
Binks Mfg. Co.
Brabender Corp.
Bristol Co.
Builders-Providence Div. B-I-F Industries
Central Scientific Co.
Consolidated Electrodynamics Corp.
Crosby Valve & Gage Co.
Falcon Alarm Co., Inc.
Fischer & Porter Co.
Foxboro Co.
General Electric Co. Apparatus Sales Div.
Hagan Chemicals & Controls, Inc. Divisions: Calgon Co., Hall Laboratories
Illinois Testing Laboratories, Inc.
INDUSTRIAL PHYSICS & ELECTRONICS CO.
Isotope Products, Inc. Instrument Div.
Jordan Corp.
Leupold & Stevens Instruments, Inc.
Lonergan Co., J. E.
Lunkenheimer Co.
Meriam Instrument Co.
Minneapolis-Honeywell Regulator Co. Brown Instrument Div.
Minneapolis-Honeywell Regulator Co. Industrial Div.
New Jersey Meter Co.
Norden-Ketay Corp.
Nuclear Research Corp.
Powell Co., Wm.
Precision Thermometer & Instrument Co.
Republic Flow Meters Co.
Revere Corp. of America
Rockwell Mfg. Co.
Roots-Connersville Blower Div. Dresser Industries, Inc.
Schroeder Brothers Corp.
Southwestern Industrial Electronics Co.
Texas Instruments, Inc. Industrial Instrumentation Div.
Uehling Instrument Co.
U. S. Gauge Div. American Machine & Metals, Inc.
Weston Instruments, Div. Daystrom, Inc.

METERS & GAGES, HARDNESS TESTING

METERS & GAGES, ETC., LINEAR MEASURE (CALIPERS, MICROMETERS, ET AL)

Lufkin Rule Co.
Minneapolis-Honeywell Regulator Co. Brown Instrument Div.
Nuclear Research Corp.
Snap-on-Tools Corp.
Texas Instruments, Inc. Industrial Instrumentation Div.
Tracerlab, Inc.
Uehling Instrument Co.

METERS & GAGES, ETC., LIQUID (& SLURRY) DENSITY

Bailey Meter Co.
Beckman Instruments, Inc. Berkeley Div.

Binks Mfg. Co.
Bristol Co.
Fischer & Porter Co.
Foxboro Co.
General Electric Co. Apparatus Sales Div.
Hagan Chemicals & Controls, Inc. Divisions: Calgon Co., Hall Laboratories
INDUSTRIAL PHYSICS & ELECTRONICS CO.
Isotope Products, Inc. Instrument Div.
Macbeth Daylighting Corp.
MINE & SMELTER SUPPLY CO. MARCY MILL DIV.
Minneapolis-Honeywell Regulator Co.
Nuclear Research Corp.
Precision Thermometer & Instrument Co.
Roots-Connersville Blower Div. Dresser Industries, Inc.
Texas Instruments, Inc. Industrial Instrumentation Div.
Tracerlab, Inc.
Uehling Instrument Co.

METERS & GAGES, ETC., SPEED (TACHOMETER, ETAL)

Auto-Lite Battery Corp.
Bailey Meter Co.
Beckman Instruments, Inc. Berkeley Div.
Bristol Co.
Chatillon & Sons, John
Electro Products Laboratories
Esterline-Angus Co., Inc.
Foxboro Co.
General Electric Co. Apparatus Sales Div.
Ideal Industries, Inc.
Metron Instrument Co.
Minneapolis-Honeywell Regulator Co. Industrial Div.
Norden-Ketay Corp.
Reliance Electric & Engineering Co.
Stewart-Warner Corp. Alemite Div.
Texas Instruments, Inc. Industrial Instrumentation Div.
Weston Instruments, Div. Daystrom, Inc.

METERS & GAGES, ETC., TEMPERATURE (THERMOMETERS, PYROMETERS, ETC.)

Assembly Products, Inc.
Auto-Lite Battery Corp.
Bailey Meter Co.
Blue M Electric Co.
Bristol Co.
Central Scientific Co.
Eisler Engineering Co.
Engelhard Industries Inc.
Fischer & Porter Co.
Fisher Scientific Co.
Foxboro Co.
General Electric Co. Apparatus Sales Div.
Gray Instrument Co.
H-B Instrument Co., Inc.
Hagan Chemicals & Controls, Inc. Divisions: Calgon Co., Hall Laboratories
Illinois Testing Laboratories, Inc.
INDUSTRIAL PHYSICS & ELECTRONICS CO.
Leeds & Northrup Co.
Minneapolis-Honeywell Regulator Co. Brown Instrument Div.
Minneapolis-Honeywell Regulator Co. Industrial Div.
Precision Thermometer & Instrument Co.
Republic Flow Meters Co.
Texas Instruments, Inc. Industrial Instrumentation Div.
U. S. Gauge Div., American Machine & Metal, Inc.
Weston Instruments, Div. Daystrom, Inc.
Wheelco Instr. Div. Barber-Colman Co.

METERS & GAGES, ETC., TIME (CLOCKS, ETC.)

Bristol Co.
General Electric Co. Apparatus Sales Div.
Rockwell Mfg. Co.
Sangamo Electric Co.
Texas Instruments, Inc. Industrial Instrumentation Div.

(MILLS—see below; also see: Crushers; Pulverizers)

MILLS, GRINDING AUTOGENOUS

Aerofall Mills, Inc.
HARDINGE CO., INC.
Majac Inc.
Mead Mill Co.
Williams Patent Crusher & Pulverizer Co.

MILLS, GRINDING, BALL, PEBBLE, ROD & TUBE

Abbé Engineering Co.
BABCOCK & WILCOX CO.
Black's Machine Shop
Booth Co.
Combustion Engineering Inc.
Coors Porcelain Co.
DIESEL ENERGY CORP.
DENVER EQUIPMENT CO.
DRAVO CORP.
Eastern Electro-Casting Co., Ltd.
EIMCO CORP.
Fisher Scientific Co.
Foster Wheeler Corp.
Gallgher Co.
HARDINGE CO., INC.
Hirsch Bros. Machy. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
MINE & SMELTER SUPPLY CO., MFG. DIV.
Morse Bros. Machinery Co.
NORDBERG MFG. CO.
Patterson Foundry & Machine Co.
Sheffield Div. Armco Steel Corp.
SMIDTH & CO., F. L.
STEARNS ROGER MFG. CO.
Straub Mfg. Co.
TRAYLOR ENGINEERING & MFG. CO.
VULCAN IRON WORKS CO. (VULCAN—DENVER)

MILLS, MOBILE UNIT (COMPLETE ORE DRESSING) — does not include Crushers, Mobile Units alone

CARPCO MANUFACTURING, INC.
DENVER EQUIPMENT CO.
Kenyon Walker Machinery Co.
WESTERN MACHINERY CO.

(MILLS, PUG—see Scrubbers)

MILL BALLS & SIMILAR MEDIA, GRINDING

Abbé Engineering Co.
Allis-Chalmers Mfg. Co. Industries Group
American Forge Co.
BABCOCK & WILCOX CO.
Calumet Div. Calumet & Hecla, Inc.
COATES STEEL PRODUCTS CO.
Coeur d'Alene Hardware & Foundry Co.
COLORADO FUEL & IRON CORP.
Coors Porcelain Co.
DENVER EQUIPMENT CO.
Endicott Forging & Mfg. Co.
Foster Wheeler Corp.
HARDINGE CO., INC.
Kennedy-Van Saun Mfg. & Eng. Corp.
NATIONAL MALLEABLE & STEEL CASTINGS CO.
Patterson Foundry & Machine Co.
Sheffield Div. Armco Steel Corp.
Tennessee Coal & Iron Div. U. S. Steel Corp.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
Vanadium-Alloys Steel Co.

MILL LINERS, GRINDING

Abbé Engineering Co.
Allis-Chalmers Mfg. Co. Industries Group
American Brake Shoe Co. American Manganese Steel Div.
Baldwin-Lima-Hamilton Corp. Standard Steel Works Div.
Calumet Div. Calumet & Hecla, Inc.
Coors Porcelain Co.
Dagley Mfg. Co.
DENVER EQUIPMENT CO.
EIMCO CORP.
HARDINGE CO., INC.
Hirsch Bros. Machy. Co.
Kensington Steel Div., Poor & Co.
LINATEX CORP. OF AMERICA
Los Angeles Steel Casting Co.
NATIONAL MALLEABLE & STEEL CASTINGS CO.
NORDBERG MFG. CO.
Patterson Foundry & Machine Co.
Sorel Steel Foundries, Ltd.
STEARNS ROGER MFG. CO.
Tennsssee Coal & Iron Div. U. S. Steel Corp.
Thomas Foundries, Inc.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.

MILL RODS, GRINDING

Abbé Engineering Co.
Allis-Chalmers Mfg. Co. Industries Group
American Brake Shoe Co. American Manganese Steel Div.
American Forge Co.
COLORADO FUEL & IRON CORP.
DENVER EQUIPMENT CO.
HARDINGE CO., INC.
Kennedy-Van Saun Mfg. & Eng. Corp.
Sheffield Div. Armco Steel Corp.
Tennessee Coal & Iron Div. U. S. Steel Corp.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.

MILL SHELLS, GRINDING

Abbé Engineering Co.
Allis-Chalmers Mfg. Co. Industries Group
Baldwin-Lima-Hamilton Corp. Standard Steel Works Div.
DENVER EQUIPMENT CO.
HARDINGE CO., INC.
Kennedy-Vaun Saun Mfg. & Eng. Corp.
NORDBERG MFG. CO.
SMIDTH & CO., F. L.
STEARNS ROGER MFG. CO.
TRAYLOR ENGINEERING & MFG. CO.

(MINE CARS—see Cars, Mine)

MINE DOORS (including Automatic Pressure, Safety, Watertight, etc.)

AMERICAN MINE DOOR CO.
Coeur d'Alene Hardware & Foundry Co.
SUN SHIPBUILDING & DRY DOCK CO.

(MINE SUPPORTS — see below; also see: Steel; Rock Bolts; Fencing, Metal Wire)

MINE SUPPORTS, METAL, SETS & ARCH PLATES

Bethlehem Steel Co., Inc.
Commercial Shearing & Stamping Co.
Dept. EMJ-MG
Herold Mfg. Co.
Irwin Foundry & Mine Car Co.
Rockiron Co., Ltd.
Sutton Steele & Steele, Inc.

MINE SUPPORTS, METAL, YIELDABLE SETS & ARCHES

Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Irwin Foundry & Mine Car Co.

MINE SUPPORTS, METAL—PROPS (including reusable, movable & yieldable types)

Douety Mining Equipment Ltd.
Duff Norton Co.
Herold Manufacturing Co.
Irwin Foundry & Mine Car Co.
Templeton, Kenly & Co.

MINERAL DEALERS & SALES AGENTS

American Metal Co.
ASSOCIATED METALS & MINERALS CORP.
American Smelting & Refining Co.
Calabrian Co., Inc.
Continental Mineral Processing Co.
Continental Ore Corp.
DeSousa Co., Inc., J. E.
Engelhard Industries Inc.
GODOY & CO., INC., E. A.
Grace & Co., W. R.
Haesler Metal & Ore Corp.
Handy & Harman
INTERNATIONAL BARTERING CO.
INTERNATIONAL MINERALS & METALS CORP.
Metal & Thermit Corp.
Metal Traders Inc.
Minerals Engineering Co.
New Jersey Zinc Co.
Overseas Raw Materials Corp.
Philipp Bros., Inc.
Pitkin, Inc., Lucius
Tennant Sons & Co., C. of N. Y.
Ultra-Violet Products, Inc.
U. S. Smelting, Refining & Mining Co. Inc.
Vale Do Rio Doce Trading Co., Inc.
Wah Chang Corp.

MINERAL SPECIMENS

MINERAL SPECIMEN PREPARATION (THIN SECTS., ETC.)

Cal-Brea

(MIXERS—see Agitators)

MONITOR, HYDRAULIC (WATER)

Chiksan Co.

(MOTORS—see: Air Motors; Electric Motors; Hydraulic Motors)

(MUCKING MACHINES—see Loaders)

N

NODULIZING EQUIPMENT—also see; Sintering Equipment; Pelletizing Equip.; Briquetting Equip.

Dravo Corp.
Dwight-Lloyd Div. McDowell Co., Inc.
GOULD CO., GORDON I.
HARDINGS CO., INC.
Kennedy-Van Saun Mfg. & Eng. Corp.
LINK-BELT CO.
McDowell Co., Inc.
Wellman Engineering Co. McDowell Enterprise

NOZZLES—does not include Monitors, Hydraulic

Bete Fog Nozzle, Inc.
Binks Mfg. Co.
Booth Co.
Branford Co.
Chain Belt Co.
Deister Concentrator Co.
Deister Machine Co.
Elkhart Brass Mfg. Co., Inc.
Johnson-March Corp.
Jordan Corp.
LINK-BELT Co.
Norton Co.
Pangborn Corp.
Penberthy Mfg. Co.
Pettinos, Inc., George F.
SPRAYING SYSTEMS CO.
U. S. Rubber Co.
Yarnall-Waring Co.
Yuba Consolidated Industries, Inc., Yuba Mining Div.

O

OFFICE MACHINES & EQUIPMENT—does not include: Computing Machines; Drafting Equip.

Automatic Electric Co.
Bruning Co., Inc. Charles
Ozalid Div. General Aniline & Film Corp.
Peerless Photo Products, Inc.
Remington Rand Div. Sperry Rand Corp.
Republic Steel Corp.
Taller & Cooper, Inc.

(ORE, DEALERS—See Mineral Dealers and Sales Agents)

P

PACKING

Acme Rubber Mfg. Co.
Belmont Packing & Rubber Co.
Boston Woven Hose & Rubber Co.
Chemical & Power Products, Inc.
Durirron Co., Inc.
Felt Products Mfg. Co.
Garlock Packing Co.
Gatke Corp.
Goodall Rubber Co.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co.
Graton & Knight Co., Inc.
Greene, Tweed & Co.
Hamilton Rubber Mfg. Corp.
HEWITT-ROBINS, INC.
Houghton & Co., E. F.
Johns-Manville
Keasbey & Mattison Co.
New York Belting & Packing Co.
Philadelphia Belting Co.
Quaker Rubber Div. H. K. Porter Company, Inc.
Raybestos-Manhattan, Inc. Manhattan Rubber Div.
Republic Rubber Div. Lee Rubber & Tire Corp.
Rhoads & Son, J. E.
Snyder & Son, Inc., M. L.
Union Asbestos & Rubber Co.
U. S. Rubber Co. Mechanical Goods Div.
Westinghouse Air Brake Co. Ind. Products Div.

PAINTS—also see Coatings

Aluminum Co. of America
Amercoat Corp.
Cabot, Inc., Samuel
Canadian Industries Ltd.
Carboline Co.
Carbolineum Wood Preserving Co.
Carey Mfg. Co., Philip
Dixon Crucible Co., Joseph
DuPont de Nemours & Co., E. I.
Koppers Co. Inc.
Master Bronze Powder Co., Inc.
Metal & Thermit Corp.
National Lead Co.
Pennsalt Chemicals Corp.
Quigley Co., Inc.
Ruberoid Co.
Rust-Oleum Corp.
Sherwin-Williams Co.
Wilbur & Williams Co.

PELLETIZING-BALLING EQUIPMENT — does not include: Sintering Equip.; Nodulizing Equip.; Briquetting Equip.

Canadian Locomotive Co., Ltd.
HARDINGE CO., INC.
NORDBERG MFG. CO.

PETROLEUM PRODUCTS also see Lubricants

Borne Chemical Co.
Brooks Oil Co.
Cities Service Oil Co.
Gulf Oil Corp.
Houghton & Co., E. F.
Jet-Lube, Inc.
New York & New Jersey Lubricant Co.
Phillips Petroleum Co.
Pure Oil Co.
Shell Oil Co.
Sinclair Refining Co.
STANDARD OIL CO., OF CALIFORNIA WESTERN OPERATIONS, INC.
Standard Oil Co.—Indiana
Sun Oil Co.
TEXAS CO.
Valvoline Oil Co. Div. Ashland Oil Co. Div.

(pH INDICATORS—see Meters, Chemical)

(PHOTOCOPY EQUIPMENT see Blueprint Machines

(PICKS—see: Geologist's Equipment; Tools)

(PIPE & TUBING—see below; also see Electrical Conduit)

PIPE, IRON & STEEL

Alco Products, Inc.
Armco Drainage & Metal Products, Inc.
Atlas Steels, Ltd.
BABCOCK & WILCOX CO.
Beall Pipe & Tank Corp.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Blaw-Knox Co. Power Piping & Sprinkler Div.
Byers Co., A. M.
Carpenter Steel Co.
COLORADO FUEL & IRON CORP., WICKWIRE SPENCER STEEL DIV.
CRUCIBLE STEEL CO. OF AMERICA
Dominion Steel & Coal Corp., Ltd.
Electric Steel Foundry Co.
Foster Co., L. B.
Goyne Pump Co.
Graybar Elec. Co., Inc.
Jones & Laughlin Steel Corp.
Kaiser Steel Corp.
Kellogg 'Co., M. W.
NATIONAL SUPPLY CO.
NAYLOR PIPE CO.
Ogden Iron Works
Pittsburgh Steel Co.
Republic Steel Corp.
Ryerson & Son, Inc., Joseph T.
Swepco Tube Corp.
U. S. Pipe & Foundry Co.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
U. S. STEEL CORP. NATIONAL TUBE DIV.
Wheeling Steel Corp.
Youngstown Sheet & Tube Co.

PIPE, NON-FERROUS METAL

Aluminum Co. of America
American Brass Co.
AMERICAN SMELTING & REFINING CO. FEDERATED METALS DIV.
Ampco Metal, Inc.
Foster Co., L. B.
Goyne Pump Co.
Graybar Elec. Co., Inc.
Haynes Stellite Co. Div. Union Carbide Corp.
International Nickel Co.
Kaiser Aluminum & Chemical Sales, Inc.
Mueller Brass Co.
National Lead Co.
Phelps Dodge Copper Products Corp.
Revere Copper & Brass, Inc.
Reynolds Metals Co.
Swepco Tube Corp.
Triangle Conduit & Cable Co., Inc.

PIPE (METAL), NON-METALLIC LINED

American Hard Rubber Co.
Dow Chemical Co.
Galigher Co.
Goodrich Industrial Products Co., B. F.
Graybar Elec. Co., Inc.
LINATEX CORP. OF AMERICA
Luzerne Rubber Co.
U. S. Pipe & Foundry Co.

PIPE, PLASTIC

Amercoat Corp.
American Hard Rubber Co.
Anchor Plastics Co. Inc.
Carlon Products Corp.
Crane Co.
Dow Chemical Co.
Electric Steel Foundry Co.
Evanite Plastic Co., Div. Evans Pipe Co.
Formica Corp. Subsidiary of Cyanamid
Foster Co., L. B.
Franklin Plastics Co.
Gering Products, Inc.
Goodall Rubber Co.
Goodrich Industrial Products Co. B. F.
Goodyear Tire & Rubber Co.
Graybar Elec. Co., Inc.
Irvington Div. Minnesota Mining & Mfg. Co.
Johnson Plastic Corp.
Line Material Industries
Luzerne Rubber Co.
Minnesota Mining & Mfg. Co.
Mueller Brass Co.
Plastex Co.
Quaker Rubber Div. H. K. Porter Company, Inc.
Republic Steel Corp.
Ryerson & Son, Inc., Joseph T.
Synthane Corp.
Triangle Conduit & Cable Co., Inc.
U. S. Rubber Co.
U. S. Rubber Co. Mechanical Goods Div.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
U. S. STEEL CORP. NATIONAL TUBE DIV.
Youngstown Sheet & Tube Co.

PIPE, VENTILATION — does not include Ventilation Tubing, Non-Metallic

Armco Drainage & Metal Products, Inc.
Kirk & Blum Mfg. Co.
NAYLOR PIPE CO.
Swepco Tube Corp.
Triangle Conduit & Cable Co., Inc.

PIPE, WOOD

Acme Tank Mfg. Co.
Arrow Tank Co.
Atlantic Tank Corp.
Caldwell Co., W. E.
Hauser-Stander Tank Co.
Michigan Pipe Co.
National Tank & Pipe Co.
Pacific Wood Tank Corp.
Santa Fe Tank Div. Fluor Products Co.
Sutphen, Peter O.
Windeler Co., Ltd., George

PIPE FITTINGS — also see: Pipe Line Traps; Nozzles; Valves

Alco Products, Inc.
Aluminum Co. of America
American Hard Rubber Co.
Ampco Metal, Inc.
Appleton Electric Co.
Band-It Co.
Blaw-Knox Co. Power Piping & Sprinkler Div.
Chase Brass & Copper Co.
Crane Co.
CRUCIBLE STEEL CO. OF AMERICA
Dow Chemical Co.
Dresser Mfg. Div. Dresser Industries, Inc.
Durirron Co., Inc.
Electric Steel Foundry Co.
Erie Pump & Engine Works
Evanite Plastic Co., Div. Evans Pipe Co.
Fairbanks Co.
Foster Co., L. B.
Franklin Plastics Co.
Goodrich Industrial Products Co., B. F.
Goyne Pump Co.
Grinnell Co., Inc.
Gustin-Bacon Mfg. Co.
Haynes Stellite Co. Div. Union Carbide Corp.
International Nickel Co.
Jefferson Union Co.
Johnson Plastic Corp.
Jordan Corp.
Ladish Co.
Los Angeles Steel Casting Co.
Luzerne Rubber Co.
Manning Co., Charles E.
McDowell Mfg. Co.
Meckum Engineering, Inc.
Mission Mfg. Co.
Mueller Brass Co.
NAYLOR PIPE CO.
Plastex Co.
Stockham Valves & Fittings
Swepco Tube Corp.
Triangle Conduit & Cable Co., Inc.
Tube Turns Div. National Cylinder Gas Co.
U. S. Rubber Co.
U. S. Rubber Co. Mechanical Goods Div.
VICTAULIC CO. OF AMERICA
Walworth Co.
Weatherhead Co. Fort Wayne Div.
Zurn Mfg., J. A. Div. Zurn Industries, Inc.

PIPELINE TRAPS, AIR, STEAM & WATER

Crane Co.
New Jersey Meter Co.
Yarnall-Waring Co.

(PNEUMATIC—see Air)

(POWER PLANTS—see Electric Generating Power Plants)

(POWER SHOVELS — see Excavators)

POWER TAKE-OFFS — also see Drives

Davey Compressor Co.
Drilling Accessory & Mfg. Co., Inc.
Failing Co., George E.
Gar Wood Industries, Inc.
Hayes Steel Products, Ltd.
Hendrickson Mfg. Co.
Mayhew Machine & Supply Co.
Minerals Engineering Co.
Morse Chain Co.
Rockwell Spring & Axle Co. Timken-Detroit Axle Div.
Stimmel Winch Co., Inc.
Twin Disc Clutch Co.
Western Gear Corp.

(PROFESSIONAL SERVICES—see: Consultants; Contractors; Laboratory Service)

(PROTECTIVE CLOTHING—see Safety Clothing)

(PUG MILLS—see Scrubbers)

(PULLEYS—see Blocks)

(PULLEYS, MAGNETIC—see Separators, Magnetic)

PULVERIZERS — also see: Crushers; Mills, Grinding

Abbé Engineering Co.
Acme Road Machinery Co., Inc.
Allis-Chalmers Mfg. Co. Industries Group
American Pulverizer Co.
BABCOCK & WILCOX CO.
Bartlett & Snow Co., C. O.
Bico, Inc.
Bradley Pulverizer Co.
Buffalo Hammer Mill Corp.
Combustion Engineering, Inc. Raymond Div.
DENVER EQUIPMENT CO.
Denver Fire Clay Co.
DIESEL ENERGY CORP.
Foster Wheeler Corp.
Gruendler Crusher & Pulverizer Co.
HARDINGE CO., INC.
IOWA MFG. CO.
Jeffrey Mfg. Co.
Lippmann Engineering Works, Inc.
MACHINERY CENTER INC.
Majac Inc.
Mead Mill Co.
MINE & SMELTER SUPPLY CO., MFG. DIV.
Morse Bros. Machinery Co.
Norma-Hoffman Bearings Corp.
Pulva Corp.
Pulverizing Machinery Div., Metals Disintegrating Co., Inc.
Rogers Iron Works Co.
SMIDTH & CO., F. L.
Sturtevant Mill Co.
Whiting Corp.
Williams Patent Crusher & Pulverizer Co.

PUMPS, AIR DRIVEN

Aldrich Pump Co.
American-Marsh Pumps, Inc.
Atlas Copco Pacific, Inc.
Binks Mfg. Co.
Chicago Pneumatic Tool Co.
Davidson Co., M. T.
Dorr Oliver, Inc.
Gray & Co., Inc.
Hayes Steel Products, Ltd.
Herold Mfg. Co.
Hills-McCanna Co.
Le Roi Div. Westinghouse Air Brake Co.
Lincoln Engineering Co. Div. McNeil Machine & Engineering Co.
Longyear Co., E. J.
McGowan Pump Div., Leyman Mfg. Corp.
Scramm, Inc.
Warren Pumps, Inc.
Worthington Corp.

PUMPS, AIR LIFT

Chicago Pneumatic Tool Co.
Condenser Service & Engineering Co.
INGERSOLL-RAND CO.
Nash Engineering Co.
Worthington Corp.

PUMPS, CENTRIFUGAL & TURBINE

ALLEN-SHERMAN-HOFF PUMP CO.
Allis-Chalmers Mfg. Co. Industries Group
American Crucible Products, Inc., Kenco Pump Div.
American-Marsh Pumps, Inc.
American Well Works
Ampco Metal, Inc.
Barrett Haentjens & Co.
Buffalo Forge Co.
Byron Jackson Div. Borg-Warner Corp.
Carver Pump Co.
Chain Belt Co.
Construction Machinery Co.
Davidson Co., M. T.
Dean Hill Pump Co.
DeLaval Steam Turbine Co.
Deming Co.
Dorr Oliver, Inc.
Duriron Co., Inc.
Erie Pump & Engine Works
Essick Mfg. Co.
Fairbanks, Morse & Co.
Flood City Brass & Elec. Co.
GARDNER-DENVER CO.
Gorman-Rupp Co.
Goulds Pumps, Inc.
Goyne Pump Co.
Homelite Div., Textron Inc.
INGERSOLL-RAND CO.
Jacuzzi Bros., Inc.
Jaeger Machine Co.
Johnston Pump Co.
Krogh Pump & Equipment Co., Inc.
Lawrence Pumps, Inc.
Layne & Bowler Pump Co. of Los Angeles.
Lecourtenay Co.
McDonald Mfg. Co., A. Y.
McGowan Pump Div., Leyman Mfg. Corp.
MORRIS MACHINE WORKS
McNally Pittsburg Mfg. Corp.
Mission Mfg. Co.
Morse Bros. Machinery Co.
National Carbon Co. Union Carbide Corp.
New York Air Brake Co. Aurora Pump Div.
Novo Pump & Engine Co.
Peerless Pump Div. Food Machinery & Chemical Corp.
Pennsylvania Drilling Co.
Pennsylvania Pump & Compressor Co.
Rice Pump & Machine Co.
Stanco Mfgs. & Sales, Inc.
Standard Elec. Mfg. Co., Inc.
Swaby Mfg. Co.
Warren Pumps, Inc.
Weinman Pump Mfg. Co.
Wheeler Mfg. Co., C.H., Economy Pump Div.
WILFLEY & SONS, A. R.
Worthington Corp.

(PUMPS, CONCRETE & REFRACTORY — see: Concrete; Refractories)

PUMPS, CORROSIVE LIQUIDS

Aldrich Pump Co.
ALLEN-SHERMAN-HOFF PUMP CO.
Allis-Chalmers Mfg. Co., Industries Group
American Hard Rubber Co.
American-Marsh Pumps, Inc.
Ampco Metal, Inc.
Barrett Haentjens & Co.
Binks Mfg. Co.
Brosites Products Corp.
Buffalo Forge Co.
Byron Jackson Div. Borg-Warner Corp.
Canadian Locomotive Co., Ltd.
DENVER EQUIPMENT CO.
Dorr Oliver, Inc.
Duriron Co., Inc.
Gallgher Co.
GARDNER-DENVER CO.
Goulds Pumps, Inc.
Goyne Pump Co.
Hills-McCanna Co.
Hypro Engineering, Inc.
INGERSOLL-RAND CO.
Jacuzzi Bros., Inc.
Johnston Pump Co.
Krogh Pump & Equipment Co., Inc.
Lawrence Pumps, Inc.
Lecourtenay Co.
LINATEX CORP. OF AMERICA
Lincoln Engineering Co. Div. McNeil Machine & Engineering Co.
Luzerne Rubber Co.
McGowan Pump Div., Leyman Mfg. Corp.
NAGLE PUMPS, INC.
National Carbon Co. Union Carbide Corp.
New York Air Brake Co. Aurora Pump Div.
Peerless Pump Div. Food Machinery & Chemical Corp.
Penberthy Mfg. Co.
Pennsylvania Pump & Compressor Co.
Shriver & Co., T.
Warren Pumps, Inc.
Weinman Pump Mfg. Co.
WESTERN MACHINERY CO.
Wintroath Pumps Div. Worthington Corp.
WILFLEY & SONS, A. R.
Worthington Corp.

PUMPS, DEEP WELL — also see Pumps, Submersible

American Well Works
Barnes Mfg. Co.
Byron Jackson Div. Borg-Warner Corp.
Deming Co.
Fairbanks, Morse & Co.
Food Machinery & Chemical Corp. Peerless Pump Div.
INGERSOLL-RAND CO.
Jacuzzi Bros., Inc.
Johnston Pump Co.
Kobe, Inc.
Layne & Bowler Pump Co. of Los Angeles
McDonald Mfg. Co., A. Y.
New York Air Brake Co. Aurora Pump Div.
Pennsylvania Drilling Co.
Robbins & Myers, Inc., Moyno Pump Div.
Wintroath Pumps Div. Worthington Corp.
Worthington Corp.

PUMPS, DIAPHRAGM

Barnes Mfg. Co.
Brosites Products Corp.
Carver Pump Co.
Chain Belt Co.
Construction Machy. Co.
Dagley Mfg. Co.
DENVER EQUIPMENT CO.
Dorr Oliver, Inc.
Essick Manufacturing Co.
Gorman-Rupp Co.
Homelite Div., Textron Inc.
Hypro Engineering, Inc.
Jaeger Machine Co.
Marlow Pumps Div. Bell & Gossett Co.
McGowan Pump Div. Leyman Mfg. Corp.
Morse Bros. Machinery Co.
Novo Pump & Engine Co.
Philadelphia Belting Co.
Rice Pump & Machine Co.
Shriver & Co., T.
WESTERN MACHINERY CO.
Worthington Corp.

PUMPS, DREDGE & GRAVEL —also see Pumps, Sand & Slime

ALLEN-SHERMAN-HOFF PUMP CO.
Allis-Chalmers Mfg. Co. Industries Group
American Brake Shoe Co. American Manganese Steel Div.
American Brake Shoe Co.
American Hoist & Derrick Co.
Carver Pump Co.
Ellicott Machine Corp.
Erie Pump & Engine Works
Essick Manufacturing Co.
Georgia Iron Works Co.
INGERSOLL-RAND CO.
Kansas City Hay Press
Krogh Pump & Equipment Co., Inc.
Lawrence Pumps, Inc.
Meckum Engineering, Inc.
MORRIS MACHINE WORKS
NAGLE PUMPS, INC.
Pettibone Mulliken Corp.
Sutton Steele & Steele, Inc.
Thomas Foundries, Inc.
WILFLEY & SONS, A. R.
Worthington Corp.

PUMPS, HYDRAULIC FLUID

Aldrich Pump Co.
American Instrument Co., Inc.
Anthony Co.
Commercial Shearing & Stamping Co.
Davidson Co., M. T.
DeLaval Steam Turbine Co.
Hales Co., W. M.
Houghton & Co., E. F.
INGERSOLL-RAND CO.
Johnston Pump Co.
Kobe, Inc.
Krogh Pump & Equipment Co., Inc.
Ledeen, Inc.
Lincoln Engineering Co. Div. McNeil Machine & Engineering Co.
New York Air Brake Co. Aurora Pump Div.
Oilgear Co.
Owatonna Tool Co.
Penberthy Mfg. Co.
Pennsylvania Pump & Compressor Co.
Star Jack Co.
Templeton, Kenly & Co.
Vickers Inc.
Weinman Pump Mfg. Co.
Worthington Corp.

PUMPS, HYDRAULIC RAM-TYPE

Blackhawk Mfg. Co.
Ledeen, Inc.
Lincoln Engineering Co. Div. McNeil Machine & Engineering Co.
Moran Engineering Co.
Owatonna Tool Co.

PUMPS, PISTON & PLUNGER

Aldrich Pump Co.
American-Marsh Pumps, Inc.
Davidson Co., M. T.
Deming Co.
Dorr Oliver, Inc.
Eastman-Pacific Co.
Flood City Brass & Elec. Co.
GARDNER-DENVER CO.
Hills-McCanna Co.
Kobe, Inc.
Ledeen, Inc.
Lincoln Engineering Co. Div. McNeil Machine & Engineering Co.
Marlow Pumps Div. Bell & Gossett Co.
McDonald Mfg. Co., A. Y.
McGowan Pump Div., Leyman Mfg. Corp.
NATIONAL SUPPLY CO.
Novo Pump & Engine Co.
Oilgear Co.
Oliver Corp. A. B. Farquhar Div.
Pennsylvania Drilling Co.
Sanford-Day Iron Works, Inc.
Vickers Inc.
Warren Pumps, Inc.
Worthington Corp.

PUMPS, PRIMING

American Crucible Products Co. Kenco Pump Div.
Barrett Haentjens & Co.
Duriron Co., Inc.
Goulds Pumps, Inc.
INGERSOLL-RAND CO.
Marlow Pumps Div. Bell & Gossett Co.
McGowan Pump Div. Leyman Mfg. Corp.
Nash Engineering Co.
New York Air Brake Co. Aurora Pump Div.
Penberthy Mfg. Co.
Rice Pump & Machine Co.
Worthington Corp.

(PUMPS, RECIPROCATING— see Pumps, Piston)

PUMPS, ROTARY DISPLACEMENT

Chicago Pneumatic Tool Co.
DeLaval Steam Turbine Co.
Deming Co.
Fairbanks, Morse & Co.
Goulds Pumps Inc.
Hypro Engineering, Inc.
Nash Engineering Co.
Oilgear Co.
Porto Pump Inc.
Roots-Connerswille Blower Div. Dresser Industries, Inc.
Vickers Inc.
Warren Pumps, Inc.
Worthington Corp.

PUMPS, SAND & SLIME

ALLEN-SHERMAN-HOFF PUMP CO.
Allis-Chalmers Mfg. Co. Industries Group
American Brake Shoe Co. American Manganese Steel Div.
Barrett Haentjens & Co.
CARPCO MANUFACTURING INC.
Dagley Mfg. Co.
DENVER EQUIPMENT CO.
Ellicott Machine Corp.
Erie Pump & Engine Works
Gallgher Co.
GARDNER-DENVER CO.
Georgia Iron Works Co.
Goyne Pump Co.
Herold Mfg. Co.
INGERSOLL-RAND CO.
Jaeger Machine Co.
Kansas City Hay Press
Krogh Pump & Equipment Co., Inc.
Lawrence Pumps, Inc.
LINATEX CORP. OF AMERICA
McGowan Pump Div. Leyman Mfg. Corp.
Meckum Engineering, Inc.
MORRIS MACHINE WORKS
NAGLE PUMPS, INC.
Robbins & Myers, Inc., Moyno Pump Div.
Spang & Co.
Telluride Iron Works Co.
Thomas Foundries, Inc.
Weinman Pump Mfg. Co.
WESTERN MACHINERY CO.
WILFLEY & SONS, A. R.
Worthington Corp.
Yuba Consolidated Industries, Inc.

PUMPS, SUBMERSIBLE

ALLEN-SHERMAN-HOFF PUMP CO.
American Crucible Products Co., Kenco Pump Div.
Barnes Mfg. Co.
Byron Jackson Div. Borg-Warner Corp.
Carver Pump Co.
Chicago Pneumatic Tool Co.
Deming Co.
Fairbanks, Morse & Co.
INGERSOLL-RAND CO.
Jacuzzi Bros., Inc.
Johnston Pump Co.
Layne & Bowler Pump Co. of Los Angeles
McDonald Mfg. Co., A. Y.
New York Air Brake Co. Aurora Pump Div.
Peerless Pump Div. Food Machinery & Chemical Corp.
Penberthy Mfg. Co.
Pennsylvania Drilling Co.
Schramm, Inc.
Stanco Mfgs. & Sales, Inc.
Swaby Mfg. Co.
Weinman Pump Mfg. Co.
Wintroath Pumps Div. Worthington Corp.
Worthington Corp.

PUMPS, SUMP

ALLEN-SHERMAN-HOFF PUMP CO.
American Crucible Products Co., Kenco Pump Div.
American-Marsh Pumps, Inc.
Atlas Copco Eastern, Inc.
Atlas Copco Pacific, Inc.
Barnes Mfg. Co.
Barrett Haentjens & Co.
Buffalo Forge Co.
Byron Jackson Div. Borg-Warner Corp.
Canadian Locomotive Co., Ltd.
Carver Pump Co.
Chicago Pneumatic Tool Co.
Davidson Co., M. T.
Deming Co.
DENVER EQUIPMENT CO.
Essick Manufacturing Co.
Fairbanks, Morse & Co.
Gallgher Co.
GARDNER-DENVER CO.
Gorman Rupp Co.
Goulds Pumps, Inc.
Holman Bros.-Canada Ltd.
INGERSOLL-RAND CO.
Jacuzzi Bros., Inc.
Jaeger Machine Co.
Johnston Pump Co.
Krogh Pump & Equipment Co., Inc.
Lawrence Pumps, Inc.
Layne & Bowler Pump Co. of Los Angeles
Le Roi Div. Westinghouse Air Brake Co.
McDonald Mfg. Co., A. Y.
McGowan Pump Div. Leyman Mfg. Corp.
NAGLE PUMPS, INC.
New York Air Brake Co. Aurora Pump Div.
Peerless Pump Div. Food Machinery & Chemical Corp.
Penberthy Mfg. Co.
Reed Roller Bit Co.
Rice Pump & Machine Co.
Robbins & Myers, Inc., Moyno Pump Div.
Schramm, Inc.
Stanco Mfgs. & Sales, Inc.
Standard Elec. Mfg. Co., Inc.
Swaby Mfg. Co.
Telluride Iron Works Co.
Thor Power Tool Co.
Warren Pumps, Inc.
Weinman Pump Mfg. Co.
WESTERN MACHINERY CO.
Westinghouse Air Brake Co.
Wheeler Mfg. Co., C. H., Economy Pumps Div.
Wintroath Pumps Div. Worthington Corp.
Worthington Corp.

PUMPS, VACUUM

Allis-Chalmers Mfg. Co. Industries Group Group
American-Marsh Pumps, Inc.
Barrett Haentjens & Co.
Beach-Russ Co.
Bruning Co., Inc. Charles

Central Scientific Co.
Chicago Pneumatic Tool Co.
Consolidated Electrodynamics Corp.
Davidson Co., M. T.
Eisler Engineering Co.
Fuller Co.
GARDNER-DENVER CO.
General American Transportation Corp.
Goyne Pump Co.
INGERSOLL-RAND CO.
Jaeger Machine Co.
Joy Mfg. Co.
McGowan Pump Div., Leyman Mfg. Corp.
Nash Engineering Co.
Penberthy Mfg. Co.
Pennsylvania Pump & Compressor Co.
Precision Thermometer & Instrument Co.
Roots-Connersville Blower Div. Dresser Industries, Inc.
Warren Pumps, Inc.
Wheeler Mfg. Co., C. H., Economy Pump Div.
Worthington Corp.

PUMP ACCESSORIES

Barrett Haentjens & Co.
Cutler-Hammer, Inc.
Gatke Corp.
Jacuzzi Bros., Inc.
U. S. Rubber Co.

(PYROMETERS — see Meters, Temperature)

R

RADIATION DETECTORS

Automatic Switch Co.
Beckman Instruments, Inc. Berkeley Div.
CARPCO MANUFACTURING, INC.
Corning Glass Works
Curtiss-Wright Corp. Electronics Div.
Detectron Corp.
Engineers Syndicate, Ltd.
Fisher Research Laboratory, Inc.
General Electric Co. Apparatus Sales Div.
Geophysical Instrument & Supply Co.
Menlo Research Laboratory
Mt. Sopris Instrument Co.
Nuclear-Chicago Corp.
Nuclear Research Corp.
Phillips Electronics, Inc. Instruments Div.
Precision Radiation Instruments, Inc.
Radiation Counter Laboratories
Special Instruments Laboratory, Inc.
Tracerlab, Inc.
Ultra-Violet Products, Inc.
Universal Atomics Div. Universal Transistor Products Corp.
Victoreen Instrument Co.
Western Radiation Laboratory
Whites Electronics

(RADIO—see Communications)

RAIL & TRACK

American Brake Shoe Co. American Manganese Steel Div.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
COLORADO FUEL & IRON CORP.
Dominion Steel & Coal Corp., Ltd.
Foster Co., L. B.
Frank, M. K.
Gibraltar Equipment & Mfg. Co.
Ryerson & Son, Inc., Joseph T.
Sweet's Steel Co.
Tennessee Coal & Iron Div. U. S. Steel Corp.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
West Virginia Works Connors Steel Div. H. K. Porter Company, Inc.(Delaware)
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.

RAIL & TRACK ACCESSORIES — also see specific item under Car . . . Rail . . . or Track

American Brake Shoe Co.
AMERICAN MINE DOOR CO.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
CARD IRON WORKS, C. S.
Cheatham Electric Switching Device Co.
COLORADO FUEL & IRON CORP.
Conley Frog & Switch Co.
Dominion Steel & Coal Corp., Ltd.
Duquesne Mine Supply Co.
Farrell-Cheek Steel Co.
Foster Co., L. B.
Frank, M. K.
Gibraltar Equipment & Mfg. Co.
Miners' Hardware Supply Co.
Nachod & U. S. Signal Co.
Nolan Co.
Tennessee Coal & Iron Div. U. S. Steel Corp.
Utility Mine Equipment Co.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
West Virginia Works Connors Steel Div. H. K. Porter Company, Inc.(Delaware)
Whiting Corp.
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.

RAIL BENDERS

Aldon Co.
CARD IRON WORKS, C. S.
Duquesne Mine Supply Co.
Foster Co., L. B.
Frank, M. K.
Gibraltar Equipment & Mfg. Co.
Utility Mine Equipment Co.

RAIL BONDS

AMERICAN MINE DOOR CO.
American Steel & Wire Div. U. S. Steel Corp.
Ensign Electric & Mfg. Co.
Frank, M. K.
Hales Co., W. M.
Ohio Brass Co.
Penn Machine Co.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.

RAIL BRACES

American Brake Shoe Co.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
CARD IRON WORKS, C. S.
Conley Frog & Switch Co.
Coover Railroad Track Brace Co.
Foster Co., L. B.
Frank, M. K.
Gibraltar Equipment & Mfg. Co.
Nolan Co.
Pettibone Mulliken Corp.
Tennessee Coal & Iron Div.. U. S. Steel Corp
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
West Virginia Works Connors Steel Div. H. K. Porter Company, Inc. (Delaware)

RAIL CLAMPS, FISHPLATES, TIE-PLATES & FROGS

American Brake Shoe Co. American Manganese Steel Div.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
CARD IRON WORKS, C. S.
COLORADO FUEL & IRON CORP.
Conley Frog & Switch Co.
Dominion Steel & Coal Corp., Ltd.
Foster Co., L. B.
Frank, M. K.
Frog, Switch & Mfg. Co.
Gibraltar Equipment & Mfg. Co.
Pettibone Mulliken Corp.
Tennessee Coal & Iron Div. U. S. Steel Corp.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
West Virginia Works Connors Steel Div. H. K. Porter Company, Inc. (Delaware)
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.

RAIL DRILLS & PUNCHES

Foster Co., L. B.
Frank, M. K.
Gibraltar Equipment & Mfg. Co.
NORDBERG MFG. CO.
Ohio Brass Co.

RAIL SIGNALS — also see Communications

AMERICAN MINE DOOR CO.
Bethlehem Pacific Coast Steel Corp.
Frank, M. K.
General Equipment & Mfg. Co.
Miners' Hardware Supply Co.
Nachod & U. S. Signal Co.
National Filter Media Corp.
Taller & Cooper, Inc.
Union Switch & Signal Div., Westinghouse Air Brake Co.

RAIL SPIKES

Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
COLORADO FUEL & IRON CORP.
Dominion Steel & Coal Corp., Ltd.
Foster Co., L. B.
Frank, M. K.
Gibraltar Equipment & Mfg. Co.
Republic Steel Corp.
Ryerson & Son, Inc., Joseph T.
Sheffield Div. Armco Steel Corp.
Tennessee Coal & Iron Div. U. S. Steel Corp.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.
Youngstown Sheet & Tube Co.

RAIL SWITCHES & CROSSINGS

American Brake Shoe Co.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
CARD IRON WORKS, C. S.
Conley Frog & Switch Co.
Foster Co., L. B.
Frank, M. K.
Frog, Switch & Mfg. Co.
Gibraltar Equipment & Mfg. Co.
Tennessee Coal Iron Div. U. S. Steel Corp.
U. S. STEEL CORP., COLUMBIA GENEVA STEEL DIV.
West Virginia Works Connors Steel Div. H. K. Porter Company, Inc. (Delaware)

RAIL SWITCH THROWERS

AMERICAN MINE DOOR CO.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
CARD IRON WORKS, C. S.
CHEATHAM ELECTRIC SWITCHING DEVICE CO.
Conley Frog & Switch Co.
Foster Co., L. B.
Frank, M. K.
General Equipment & Mfg. Co.
Tennessee Coal & Iron Div. U. S. Steel Corp.
Union Switch & Signal Div. Westinghouse Air Brake Co.
West Virginia Works Connors Steel Div. H. K. Porter Company, Inc. (Delaware)

RAIL TIES, STEEL

Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Foster Co., L. B.
Frank, M. K.
Sweet's Steel Co.
U. S. STEEL CORP. COLUMBIA GENEVA STEEL DIV.
West Virginia Works Connors Steel Div. H. K. Porter Company, Inc. (Delaware)

(REAGENTS—see: Chemicals; Flotation Reagents; Water Clarification Chemicals)

(REAGENT FEEDERS — see Feeders)

(RECTIFIERS — see Electric Rectifiers)

(REFRACTORIES—see below; also see Insulation)

REFRACTORIES, BRICK

BABCOCK & WILCOX CO.
Corhart Refractories Co.
Denver Fire Clay Co.
Electro Refractories & Abrasives Corp.
General Refractories, Co.
Gladding McBean & Co.
Green Fire Brick Co., A. P.
HARBISON-WALKER REFRACTORIES CO.
Ironton Fire Brick Co.
Johns-Manville
Kaiser Aluminum & Chemical Sales, Inc.
Laclede-Christy Works, Refractories Div., H. K. Porter Co., Inc.
Mexico Refractories Co.
Mullite Works Refractories Div. H. K. Porter Company, Inc.
National Lead Co.
North American Refractories Co.
Norton Co.
Quigley Co., Inc.
Refractory & Insulation Corp.
Robinson Clay Product Co.
Samuel & Co., Inc., Frank

REFRACTORIES, CASTABLE

BABCOCK & WILCOX CO.
Denver Fire Clay Co.
Electro Refractories & Abrasives Corp.
General Refractories, Co.
Gladding, McBean & Co.
Green Fire Brick Co., A. P.
HARBISON-WALKER REFRACTORIES CO.
Ironton Fire Brick Co.
Johns-Manville
Laclede-Christy Works, Refractories Div., H. K. Porter Co., Inc.
Mexico Refractories Co.
Mullite Works Refractories Div. H. K. Porter Company, Inc.
North American Refractories Co.
Norton Co.
Pettinos, Inc., George F.
Quigley Co., Inc.
Refractory & Insulation Corp.
Robinson Clay Product Co.
Sauereisen Cement Co.
Samuel & Co., Inc., Frank

REFRACTORY CEMENT

BABCOCK & WILCOX CO.
Carey Mfg. Co., Philip
Corhart Refractories Co.
Denver Fire Clay Co.
Dixon Crucible Co., Joseph
Eagle-Picher Co.
Electro Refractories & Abrasives Corp.
General Refractories Co.
Gladding, McBean & Co.
Green Fire Brick Co., A. P.
HARBISON-WALKER REFRACTORIES CO.
Ironton Fire Brick Co.
Johns-Manville
Laclede-Christy Works, Refractories Div., H. K. Porter Co., Inc.
Mexico Refractories Co.
Mullite Works Refractories Div. H. K. Porter Company, Inc.
National Carbon Co. Div. Union Carbide Corp.
North American Refractories Co.
Norton Co.
Pettinos, Inc., George F.
Quigley Co., Inc.
Refractory & Insulation Corp.
Robinson Clay Product Co.
Samuel & Co., Inc., Frank
Sauereisen Cement Co.

REFRACTORY MATERIAL OTHER THAN ABOVE

Aluminum Co. of America
BABCOCK & WILCOX CO.
Denver Fire Clay Co.
General Refractories, Co.
Gladding, McBean & Co.
Green Fire Brick Co., A. P.
HARBISON-WALKER REFRACTORIES CO.
Ironton Fire Brick Co.
Johns-Manville
Klemp Metal Grating Corp.
Laclede-Christy Works, Refractories Div., H. K. Porter Co., Inc.
Mexico Refractories Co.
MONSANTO CHEMICAL CO.
Mullite Works, Refractories Div. H. K. Porter Co., Inc.
National Carbon Co. Div. Union Carbide Corp.
Norton Co.
Quigley Co., Inc.
Refractory & Insulation Corp.
Reintjes Co., George P.
Robinson Clay Product Co.

REFRACTORY PLACERS, SPRAYERS, PUMPS & BLOWERS

Cement Gun Co.
Engineered Equipment Inc.
Mexico Refractories Co.
Quigley Co., Inc.

(RESPIRATORS — see Safety Respirators)

RETORTS & DISTILLATION PROCESS EQUIPMENT LIQUID,—does not in-

clude: Boilers; Laboratory Equipment

Standard Steel Corp.

RETORTS & DISTILLATION PROCESS EQUIPMENT, SOLID—also see: Furnaces; Kilns; does not include Laboratory Equipment

GOULD CO., GORDON I.
Hevi-Duty Electric Co.
Standard Steel Corp.

ROCK (& ROOF) BOLTS

American Bridge Div., U. S. Steel Corp.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
COLORADO FUEL & IRON CORP.
Commercial Shearing & Stamping Co. Dept. EMJ-MG
Hales Co., W. M.
Hayes Steel Products, Ltd.
Lamson & Sessions Co.
Ohio Brass Co.
Pattin Manufacturing Co.
Pittsburgh Screw & Bolt Co.
Republic Steel Corp.
Sika Chemical Corp.
West Virginia Works Connors Steel Div. H. K. Porter Co., Inc. (Delaware)
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.
Youngstown Sheet & Tube Co.

ROCK (& ROOF) BOLT ACCESSORIES

American Bridge Div., U. S. Steel Corp.
American Mine Supply Co.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Central Mine Equipment Co.
COLORADO FUEL & IRON CORP.
Continental Gin Co.
Goodyear Tire & Rubber Co. Industrial Products
Hayes Steel Products, Ltd.
Herold Mfg. Co.
INGERSOLL-RAND CO.
Ohio Brass Co.
Pattin Manufacturing Co.
Pittsburgh Screw & Bolt Co.
Sheffield Div. Armco Steel Corp.
Sika Chemical Corp.
Valve Div., Thompson Products, Inc.
West Virginia Works Connors Steel Div. H. K. Porter Company, Inc. (Delaware)
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.
Youngstown Sheet & Tube Co.

ROOF BOLTING MACHINES

Acme Machinery Co.
Atlas Copco Pacific, Inc.
Chicago Pneumatic Tool Co.
Fletcher & Co., J. H.
Hayes Steel Products, Ltd.
Holman Bros.—Canada Ltd.
INGERSOLL-RAND CO.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Le Roi Div. Westinghouse Air Brake Co.
Schroeder Brothers Corp.
Thor Power Tool Co.

ROOFING & SIDING, METAL

Aluminum Co. of America
American Brass Co.
Arrowhead Steel Buildings, Inc.
Bethlehem Steel Co., Inc.
Butler Manufacturing Co.
CRUCIBLE STEEL CO. OF AMERICA
Inland Steel Products Co.
International Nickel Co.
Kaiser Aluminum & Chemical Sales, Inc.
Mahon Co., R. C.
Republic Steel Corp.
Ryerson & Son, Inc., Joseph T.
Tennessee Coal & Iron Div., U. S. Steel Corp.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.

ROOFING & SIDING, NON-METALLIC

Carey Mfg. Co., Philip
Koppers Co. Inc.
Johns-Manville
Keasbey & Mattison Co.
Ruberoid Co.
STANDARD OIL CO. OF CALIFORNIA WESTERN OPERATIONS, INC.

ROPE & TWINE (HEMP, ET AL)—does not include Wire Rope

Van Waters & Rogers, Inc.

(RUST PREVENTIVES — see Coatings)

S

SAFETY CLOTHING, GLOVES, HATS, BELTS, SHOES, ETC.

Air Reduction Sales Co., Div. Air Reduction Co., Inc.
American Optical Co.
Bullard Co., E. D.
Goodall Rubber Co.
Goodrich Industrial Products Co., B. F.
Graton & Knight Co., Inc.
Industrial Air Products Co.
Industrial Gloves Co.
International Shoe Co.
Johns-Manville
Judsen Rubber Works, Inc.
Keasbey & Mattison Co.
Miller Equipment Co., Inc.
MINE SAFETY APPLIANCES CO.
National Mine Service Co.
Parker Safety Equipment Co.
Penn Mfg. & Supply Co.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Pulmosan Safety Equipment Corp.
Rose Mfg. Co.
Safety Clothing & Equipment Co.
Safety First Shoe Co., Inc.
Safety First Supply Co.
Snyder & Son, Inc., M. L.
U. S. Rubber Co.
Wilson Rubber Co.

SAFETY EQUIPMENT & ACCESSORIES — does not include: Dust Samplers; Safety Clothing; Safety Goggles & Masks; Safety Posters; Safety Respirators. Also see see: Fire Fighting; First Aid; Meters

Alden Co.
Falcon Alarm Co., Inc.
Justrite Manufacturing Co.
Wolf Safety Lamp Co. of America, Inc.

SAFETY GOGGLES & MASKS

Air Reduction Sales Co., Div. Air Reduction Co., Inc.
American Optical Co.
Bausch & Lomb Optical Co.
Binks Mfg. Co.
Bullard Co., E. D.
Chicago Eye Shield Co.
Industrial Air Products Co.
Johns-Manville
MINE SAFETY APPLIANCES CO.
National Mine Service Co.
Parker Safety Equipment Co.
Pulmosan Safety Equipment Corp.
Ray-O-Vac Co.
Safety Clothing & Equipment Co.
Scott Aviation Corp.
Sellstrom Mfg. Co.
U. S. Safety Service Co.
Willson Products Div. Ray-O-Vac Co.

(SAFETY POSTERS — see Signs)

SAFETY RESPIRATORS

American Optical Co.
Binks Mfg. Co.
Bullard Co., E. D.
Chicago Eyeshield Co.
Flexo Products, Inc.
MINE SAFETY APPLIANCES CO.
National Mine Service Co.
Pulmosan Safety Equipment Corp.
Ray-O-Vac Co.
Safety Clothing & Equipment Co.
Scott Aviation Corp.

SAMPLING DEVICES, ORE, CONCENTRATE, ETC. (MECHANICAL) — does not include: Meters

Canadian Locomotive Co., Ltd.
CARPCO MANUFACTURING, INC.
Dagley Mfg. Co.
DENVER EQUIPMENT CO.
Galigher Co.
HARDINGE CO., INC.
Heyl & Patterson, Inc.
MACHINERY CENTER INC.
MINE & SMELTER SUPPLY CO., MFG. DIV.
Sturtevant Mill Co.

(SAWS — see below; also see Tools)

SAWS, CONCRETE & MASONRY

Clipper Mfg. Co.
Engineered Equipment Inc.

SCALES, AUTOMATIC WEIGHING — also see Feeders

ABCs Scale Div. McDowell Co., Inc.
Aerofall Mills, Inc.
Buffalo Scale Co., Inc.
Butler Bin Co.
Consolidated Packaging Machinery Corp.
Erie Strayer Co.
Fairbanks, Morse & Co.
Howe Scale Co., Inc.
INDUSTRIAL PHYSICS & ELECTRONICS CO.
Johnson Co., C. S.
McDowell Co., Inc.
MERRICK SCALE MFG. CO.
Richardson Scale Co.
St. Regis Paper Co.
SCHAFFER POIDOMETER CO.
Streeter-Amet Co.
Taller & Cooper, Inc.
Thurman Machine Co.
Toledo Scale Co.
Torsion Balance Co.
Trans-Weigh Corp.
Voland & Sons, Inc.
Webb Corp.

SCALES, PLATFORM

Bonded Scale & Machine Co.
Buffalo Scale Co., Inc.
Chatillon & Sons, John
Fairbanks, Morse & Co.
Howe Scale Co., Inc.
Johnson Co., C. S.
Streeter-Amet Co.
Taller & Cooper, Inc.
Thurman Machine Co.
Toledo Scale Co.
Webb Corp.

SCALES, SACKING

Bemis Bro. Bag Co.
Consolidated Packaging Machinery Corp.
Fairbanks, Morse & Co.
Howe Scale Co., Inc.
Richardson Scale Co.
St. Regis Paper Co.
Toledo Scale Co.

SCALES, WEIGH HOPPER — also see Feeders

ABCs Scale Div. McDowell Co., Inc.
Atlas Car & Mfg. Co.
Buffalo Scale Co., Inc.
Butler Bin Co.
Engineered Equipment Inc.
Erie Strayer Co.
Fairbanks, Morse & Co.
Howe Scale Co., Inc.
Johnson Co., C. S.
Manning, Maxwell & Moore, Inc. Shaw Box Crane & Hoist Div.
Nolan Co.
Richardson Scale Co.
Streeter-Amet Co.
Taller & Cooper, Inc.
Thurman Machine Co.
Toledo Scale Co.
Webb Corp.

(SCIENTIFIC INSTRUMENTS —see: Laboratory & Scientific Instruments; Chemical Lab. Equip; Meters; Geophysical Instruments; Spectroscopic Instruments; Drafting Equip.; Surveying Equip.)

(SCINTILLATION COUNTERS—see Radiation Detectors)

(SCRAPERS, DRAGLINE — see: Buckets, Dragline Scraper-Slusher; Hoists, Dragline Scraper-Slusher Excavators, Dragline Tower)

SCRAPERS, WHEELED, SELF-PROPELLED & TOWED (EARTHMOVING)

Allis-Chalmers Mfg. Co. Industries Group Machy. Div.
American Tractor Equipment Corp.
Ateco Div. Greenville Steel Car Co.
Caterpillar Tractor Co.
Clark Equipment Co. Construction Machinery Div.
Continental Copper & Steel Industries Inc. Wooldridge Div.
Euclid Div. General Motors Corp.
International Harvester Export Co.
Landis Steel Co.
LE TOURNEAU-WESTINGHOUSE CO.
Oliver Corp.

(SCREEN CLOTH—see Wire Cloth)

SCREEN ECCENTRICS & VIBRATORS — also see Vibrators

Davis Foundry & Machine Works
Diamond Iron Works Div. Goodman Mfg. Co.
HEWITT-ROBINS, INC.
IOWA MFG. CO.
LINK-BELT CO.
MACHINERY CENTER INC.
Southwestern Engineering Co.
Tyler Co., W. S.

SCREEN HEATERS

Allis-Chalmers Mfg. Co. Industries Group
Deister Concentrator Co.
HEWITT-ROBINS, INC.
LINK-BELT CO.
Screen Equipment Co., Inc.
Southwestern Engineering Co.
Tyler Co., W. S.

SCREEN PLATES & SHEET

American Brake Shoe Co. American Manganese Steel Div.
CARD IRON WORKS, C. S.
Chicago Perforating Co.
Hendrick Mfg. Co.
HEWITT-ROBINS, INC.
Irwin Foundry & Mine Car Co.
Kanawha Mfg. Co.
Laubenstein Mfg. Co.
LINK-BELT CO.
Manganese Steel Forge Co.
McNally Pittsburg Mfg. Corp.
Multi-Metal Wire Cloth Co., Inc.
NATIONAL MALLEABLE & STEEL CASTINGS CO.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Yuba Consolidated Industries, Inc., Yuba Mining Div.

SCREEN, WIRE & BAR

Bixby-Zimmer Engr. Co.
Buffalo Wire Works Co.
Chain Belt Co.
COLORADO FUEL & IRON CORP.
Hendrick Mfg. Co.
HEWITT-ROBINS, INC.
Hoyt Wire Cloth Co.
IOWA MFG. CO.
Jeffrey Mfg. Co.
LINK-BELT CO.
Ludlow-Saylor Wire Cloth Co.
Manganese Steel Forge Co.
McNally Pittsburg Mfg. Corp.
Newark Wire Cloth Co.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Pioneer Engineering Div. Poor & Co. Inc.
Southwestern Engineering Co.
Specialty Engineering Co.
Tyler Co., W. S.
Wedge Wire Corp.
Wickwire Spencer Steel Div. Colorado

Fuel & Iron Corp.

SCREENS, ELECTRICALLY HEATED

Acme Road Machinery Co., Inc.
Allis-Chalmers Mfg. Co. Industries Group
Deister Concentrator Co.
Deister Machine Co.
HEWITT-ROBINS, INC.
LINK-BELT CO.
Overstrom & Sons, Inc.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Productive Equipment Corp.
Screen Equipment Co., Inc.
Simplicity Engineering Co.
Southwestern Engineering Co.
Tyler Co., W. S.
Universal Vibrating Screen Co.

SCREENS, GRAVITY

American Brake Shoe Co. American Manganese Steel Div.
Chicago Perforating Co.
Colorado Fuel & Iron Corp.
Dorr-Oliver, Inc.
Hendrick Mfg. Co.
Laubenstein Mfg. Co.
LINK-BELT CO.
Lippmann Engineering Works, Inc.
Newark Wire Cloth Co.
Nolan Co.
STEARNS ROGER MFG. CO.
Tyler Co., W. S.
Universal Road Machinery Co.
Wedge Wire Corp.

SCREENS, REVOLVING (TROMMEL)

Acme Road Machinery Co., Inc.
Allis-Chalmers Mfg. Co. Industries Group
Bartlett & Snow Co., C. O.
Bodinson Manufacturing Co., Inc.
CARD IRON WORKS, C. S.
COLORADO FUEL & IRON CORP.
Chicago Perforating Co.
Davis Foundry & Machine Works
Diamond Iron Works Div., Goodman Mfg. Co.
DIESEL ENERGY CORP.
Gruendler Crusher & Pulverizer Co.
Hack Engineering Co.
Hendrick Mfg. Co.
Laubenstein Mfg. Co.
LINK-BELT CO.
Lippmann Engineering Works, Inc.
McLanahan & Stone Corp.
Minerals Engineering Co.
NATIONAL IRON CO.
Newark Wire Cloth Co.
Pioneer Engineering Div. Poor & Co. Inc.
Rogers Iron Works Co.
Smith Engineering Works
Stephens-Adamson Mfg. Co.
TRAYLOR ENGINEERING & MFG. CO.
Tyler Co., W. S.
Universal Dredge Mfg. Co.
Universal Road Machinery Co.
Washington Iron Works
Washington Machinery Co.
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.
Yuba Consolidated Industries, Inc., Yuba Mining Div.

SCREENS, SHAKING & VIBRATING

Acme Road Machinery Co., Inc.
Aerofall Mills, Inc.
Allis-Chalmers Mfg. Co. Industries Group
Bonded Scale & Machine Co.
Buffalo Wire Works Co.
C & D Div. Yuba Manufacturing Co.
Cambridge Wire Cloth Co.
Canadian Locomotive Co., Ltd.
CARPCO MANUFACTURING, INC.
Chicago Perforating Co.
COLORADO FUEL & IRON CORP.
Daniels Co. Contractors, Inc.
Davis Foundry & Machine Works
Deister Concentrator Co.
Deister Machine Co.
DENVER EQUIPMENT CO.
Diamond Iron Works Div. Goodman Mfg. Co.
DIESEL ENERGY CORP.
Dorr Oliver, Inc.
Dravo Corp.
Exolon Co.
Fahrenwald Co., A. W.
Gilson Screen Co.
Gruendler Crusher & Pulverizer Co.
Hack Engineering Co.
Hendrick Mfg. Co.
HEWITT-ROBINS, INC.
Industrial Engrg. & Construction Co.
IOWA MFG. CO.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Lecco Machinery & Engineering Co.
LINK-BELT CO.
Lippmann Engineering Works, Inc.
McNally Pittsburg Mfg. Corp.
Meckum Engineering, Inc.
Multi-Metal Wire Cloth Co., Inc.
Newark Wire Cloth Co.
NORDBERG MFG. CO.
Overstrom & Sons, Inc.
Patterson Foundry & Machine Co.
Pioneer Engineering Div. Poor & Co. Inc.
Prins & Associates, K.
Productive Equipment Corp.
Ridge Equipment Co.
Roberts & Schaefer Co., Subsidiary of Thompson Starrett Co., Inc.
Rogers Iron Works Co.
Savage Co., W. J.
Screen Equipment Co., Inc.
Simplicity Engineering Co.
Smith Engineering Works
Southwestern Engineering Co.
Specialty Engineering Co.
STEARNS ROGER MFG. CO.
Stephens-Adamson Mfg. Co.
Sturtevant Mill Co.
Syntron Co.
Tyler Co., W. S.
Universal Dredge Mfg. Co.
Universal Engineering Corp.
Universal Vibrating Screen Co.
Wedge Wire Corp.
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.
Williams Patent Crusher & Pulverizer Co.

(SCRUBBERS, ENGINE EXHAUST — see Engine Exhaust Scrubbers)

SCRUBBERS, AIR & WASTE GAS—also see: Dust Collectors; Gas Separation Process Equipment

Arrow Tank Co.
Atlantic Tank Corp.
Black Sivalls & Bryson Inc.
Chemical Construction Corp.
Dorr-Oliver Inc.
DUCON, INC.
Fuller Co.
Graver Tank & Mfg. Co., Inc.
Hagan Chemicals & Controls, Inc. Divisions: Calgon Co., Hall Laboratories
Johnson-March Corp.
Mahon Co., R. C.
McNally Pittsburg Mfg. Corp.
National Tank & Pipe Co.
Santa Fe Tank Div. Flour Products Co.
Schneible Co., Claude B.
Standard Steel Corp.

SCRUBBERS & WASHERS, MINERAL—also see: Agitators, Washing Plants

Acme Road Machinery Co., Inc.
Allis-Chalmers Mfg. Co. Industries Group
Bodinson Manufacturing Co., Inc.
Booth Co.
Daniels Co. Contractors, Inc.
Davis Foundry & Machine Works
DENVER EQUIPMENT CO.
DIESEL ENERGY CORP.
Eagle Iron Works
Georgia Iron Works Co.
Gruendler Crusher & Pulverizer Co.
Hack Engineering Co.
HARDINGE CO., INC.
Hirsch Bros. Machy. Co.
IOWA MFG. CO.
LINK-BELT CO.
Lippmann Engineering Works, Inc.
McLanahan & Stone Corp.
Meckum Engineering, Inc.
MINE & SMELTER SUPPLY CO., MFG. DIV.
Mixing Equipment Co.
Pioneer Engineering Div. Poor & Co. Inc.
Rogers Iron Works Co.
Simplicity System Co.
Smith Engineering Works
STEARNS ROGER MFG. CO.
Tyler Co., W. S.
Universal Dredge Mfg. Co.
Universal Engineering Corp.
Universal Road Machinery Co.
WESTERN MACHINERY CO.
Yuba Consolidated Industries, Inc. Yuba Mining Div.

SEPARATORS & CONCENTRATORS—see below; also see: Amalgamating Process Equipment (special); Asbestos Milling Equipment (special); Classifiers; Cyaniding Process Equipment (special); Diamond Concentrating Equipment (special); Filters; Flotation Machines; Gas Separation Equipment (special); Ion Exchange Equipment (special); Kilns; Retorts and Distillation Equipment; Screens; Scrubbers; Solvent Extraction Equipment (special); Thickeners

SEPARATORS, ELECTROSTATIC & HIGH TENSION

CARPCO MANUFACTURING, INC.

SEPARATORS, HEAVY MEDIA TYPE—for separation and recovery of media alone, see: Separators, Magnetic; Screens; or other units.

Daniels Co. Contractors, Inc.
DIESEL ENERGY CORP.
Dorr-Oliver, Inc.
Eagle Iron Works
Fuel Process Co.
HARDINGE CO., INC.
Jeffrey Mfg. Co.
LINK-BELT CO.
McNally Pittsburg Mfg. Corp.
MINE & SMELTER SUPPLY CO., MFG. DIV.
Ore & Chemical Corp.
Prins & Associates, K.
Roberts & Schaefer Co., Subsidiary of Thompson Starrett Co., Inc.
Southwestern Engineering Co.
STEARNS MAGNETIC PRODUCTS
WESTERN MACHINERY CO.

SEPARATORS, JIG, DRY

Bico Inc.
DIESEL ENERGY CORP.
Jeffrey Mfg. Co.
LINK-BELT CO.
Roberts Schaefer Co., Subsidiary of Thompson Starrett Co., Inc.
Sutton Steele & Steele, Inc.

SEPARATORS, JIG, WET

Davis Foundry & Machine Works
DENVER EQUIPMENT CO.
DIESEL ENERGY CORP.
Dorr Oliver, Inc.
Hirsch Bros. Machy. Co.
Jeffrey Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
LINK-BELT CO.
McLanahan & Stone Corp.
McNally Pittsburg Mfg. Corp.
Meckum Engineering, Inc.
Prins & Associates
WESTERN MACHINERY CO.
Yuba Consolidated Industries, Inc., Yuba Mining Div.

SEPARATORS, MAGNETIC, BELT & DRUM

CARPCO MANUFACTURING, INC.
CRUCIBLE STEEL CO. OF AMERICA
Daniels Co. Contractors, Inc.
DIESEL ENERGY CORP.
Dings Magnetic Separator Co.
Engineers Syndicate, Ltd.
Eriez Mfg. Co.
Exolon Co.
Homer Mfg. Co.
Jeffrey Mfg. Co.
Magnetic Engineering & Mfg. Co.
Shrader Co., F. W.
STEARNS MAGNETIC PRODUCTS

SEPARATORS, SHAKING TABLE, WET

CARPCO MANUFACTURING, INC.
Dagley Mfg. Co.
Deister Concentrator Co.
Deister Machine Co.
DENVER EQUIPMENT CO.
DIESEL ENERGY CORP.
Jeffrey Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
MINE & SMELTER SUPPLY CO., MFG. DIV.

SEPARATORS, SHAKING TABLE, DRY (AIR)

DIESEL ENERGY CORP
Kennedy-Van Saun Mfg. & Eng. Corp.
LINK-BELT CO.
Roberts & Schaefer Co., Subsidiary of Thompson Starrett Co., Inc.
Sutton, Steele & Steele Inc.
Wilkerson Corp.
Williams Patent Crusher & Pulverizer Co.

SEPARATORS, SLUICE (TROUGH) SPIRAL & SIMILAR FILM GRAVITY TYPES

CARPCO MANUFACTURING, INC.
Cannon Concentrator Co.
DIESEL ENERGY CORP.
LINK-BELT CO.

(SHAFT MUCKING MACHINES — see Loaders, Special Mine Shaft Mucking)

(SHEAVES — see below; also see Blocks)

SHEAVES, MINE HOIST

American Brake Shoe Co. American Manganese Steel Div.
American Hoist & Derrick Co.
CARD IRON WORKS, C. S.
CONNELLSVILLE MFG. & MINE SUPPLY CO.
Dick Co., R. & J.
Farrell-Cheeck Steel Co.
Frog, Switch & Mfg. Co.
Hirsch Bros. Machy. Co.
Holmes & Bros., Inc. Robert
Irwin Foundry & Mine Car Co.
Joy Mfg. Co.
Lake Shore, Inc.
Madesco Tackle Block Co.
MAYO TUNNEL & MINE EQUIPMENT
McKiernan-Terry Corp., Mead Morrison Div.
McMillan's Sons, W. H.
NATIONAL IRON CO.
NATIONAL MALLEABLE & STEEL CASTINGS CO.
NORDBERG MFG. CO.
Ogden Iron Works
Princeton Gripholst, Inc.
Rogers Iron Works Co.
Sanford-Day Iron Works, Inc.
Skookum Co., Inc.
Tool Steel Gear & Pinion Co.
VULCAN IRON WORKS CO. (VULCAN-DENVER)
Vulcan Iron Works Co., (Denver)
West Virginia Armature Co.
Western Block Co.
Wood's Sons Co., T. B.
Worthington Corp.
Yuba Consolidated Industries, Inc., Yuba Mining Div.

SHOP EQUIPMENT MACHINE, FABRICATING & REPAIR POWERED (LATHES) PRESSES, ETC.) — does not include Blast Cleaning Equipment; Conveyor Belting Vulcanizers; Cranes; Drill Bit & Steel Forging Hammers; Electric Cable Splicers & Vulcanizers; Forges; Furnaces; Grinders & Buffers; Hoists; Lift; Metallizing Equipment; Timber Framing Machines; Tools, Hand & Power; Welding & Cutting Equip.; Steam Cleaning Equip.

CONNELLSVILLE MFG. & MINE SUPPLY CO.
Industrial Air Products Co.
Kanawha Mfg. Co.
LOGAN ENGINEERING CO.
Master Mfg. Co.
Mead Mill Co.

Owantonna Tool Co.
Savage Co., W. J.
South Bend Lathe Works
VULCAN IRON WORKS CO. (VULCAN-DENVER)
Western Gear Corp.
Wheeler Mfg. Co., C. H.

(SHOVELS — see Excavators, Tools)

(SHUTTLE CARS—see Trucks, Shuttle Car)

(SIEVES—see below; also see Screens)

SIEVES, TESTING

Central Scientific Co.
Fahrenwald Co., A. W.
Laubenstein Mfg. Co.
Newark Wire Cloth Co.
Tyler Co., W. S.

(SIGNALS—see Communications)

SIGNS—POSTERS

Brady Co., W. H.
Dicke Tool Co.
Elliott Service Co., Inc.
MINE SAFETY APPLIANCES CO.
Safety Clothing & Equipment Co.

SINTERING EQUIPMENT (SPECIAL) — does not include: Furnaces; Kilns; Nodulizing Equipment.

Allis-Chalmers Mfg. Co. Industries Group
Builders-Providence Div. B-I-F Industries
Dravo Corp.
Dwight-Lloyd Div. McDowell Co., Inc.
Hauck Manufacturing Co.
Heyl & Patterson, Inc.
Koppers Co. Inc.
Mace Co.
McDowell Co., Inc.
Mead Mill Co.
NATIONAL MALLEABLE & STEEL CASTINGS CO.
Sanford-Day Iron Works, Inc.
Tool Steel Gear & Pinion Co.
Wellman Engineering Co. McDowell Enterprise

SKIPS & CAGES (MINE HOIST) — does not include Buckets, Hoisting & Sinking

CARD IRON WORKS, C. S.
CONNELLSVILLE MFG. & MINE SUPPLY CO.
DENVER EQUIPMENT CO.
Easton Car & Construction Co.
Helmick Foundry-Machine Co.
Hirsch Bros. Machy. Co.
Holmes & Bros., Inc. Robert
Lake Shore, Inc. Lake Shore Engineering Div.
Landis Steel Co.
MAYO TUNNEL & MINE EQUIPMENT
Miners' Hardware Supply Co.
NATIONAL IRON CO.
Nolan Co.
Ogden Iron works
Roberts & Schaefer Co., Subsidiary of Thompson Starrett Co., Inc.
Rogers Iron Works Co.
Sanford-Day Iron Works, Inc.
STEARNS ROGER MFG. CO.
Telluride Iron Works Co.
VULCAN IRON WORKS CO. (VULCAN-DENVER)

(SLUSHERS — see: Buckets; Dragline Scraper-Slusher; Hoists, Dragline Scraper-Slusher)

SOLVENT EXTRACTION PROCESS EQUIPMENT (SPECIAL) — does not include standard auxiliary equipment

Allis-Chalmers Mfg. Co. Industries Group
DENVER EQUIPMENT CO.
Mixing Equipment Co.
Santa Fe Tank Div. Fluor Products Co.
Turbo-Mixer Div. General American Transportation Corp.

SPECTROSCOPIC INSTRUMENTS

American Instrument Co., Inc.
American Optical Co.
Bausch & Lomb Optical Co.
Central Scientific Co.
Consolidated Electrodynamics Corp.
Fisher Scientific Co.
Jarrell-Ash Co.

(SPEED REDUCERS & INCREASERS—see Drives)

(SPROCKETS—see Gears)

(STACKERS — see Conveyors; Cranes)

STEAM CLEANING EQUIPMENT

Clayton Mfg. Co.
Quick Charge, Inc.

STEEL (PLATES, SHAPES, ETC.)—does not include: Buildings, Prefab; Castings; Drill Steel; Forgings; Fencing; Mine Supports; Pipe); Screen; Tanks; Wire

Allegheny Ludlum Steel Corp.
American Brake Shoe Co. American Manganese Steel Div.
BABCOCK & WILCOX CO.
Beall Pipe & Tank Corp.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Carpenter Steel Co.
COLORADO FUEL & IRON CORP.
CRUCIBLE STEEL CO. OF AMERICA
Dominion Steel & Coal Corp., Ltd.
Foster Co., L. B.
Holmes & Bros., Inc. Robert
Industrial Engr. & Construction Co.
Inland Steel Co.
Jessop Steel Co.
Jones & Laughlin Steel Corp.
Kaiser Steel Corp.
Kanawha Mfg. Co.
Lakeside Bridge & Steel Co.
Lukens Steel Co.
Midvale-Heppenstall
Moran Engineering Co.
Republic Steel Corp.
Ogden Iron Works
Pittsburgh Steel Co.
Ryerson & Son, Inc., Joseph T.
Sheffield Div. Armco Steel Corp.
Simonds Saw and Steel Co.
Tennessee Coal & Iron Div. U. S. Steel Corp.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
Wood Steel Co., Alan
Youngstown Sheet & Tube Co.

STEEL, ALLOY (PLATES, SHAPES, ETC.) — does not include: Castings Drill Steel; Forgings; Mine Supports; Pipe; Screen; Tanks; Wire

Allegheny Ludlum Steel Corp.
American Brake Shoe Co. American Manganese Steel Div.
American Steel Foundries
Atlas Steels, Ltd.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Carpenter Steel Co.
COLORADO FUEL & IRON CORP.
CRUCIBLE STEEL CO. OF AMERICA
Dominion Steel & Coal Corp., Ltd.
Electric Steel Foundry Co.
Jessop Steel Co.
Jones & Laughlin Steel Corp.
Kaiser Steel Corp.
Kanawha Mfg. Co.
Kellogg Co., M. W.
Lakeside Bridge & Steel Co.
Lukens Steel Co.
Manganese Steel Forge Co.
Midvale-Heppenstall
Moran Engineering Co.
Republic Steel Corp.
Ryerson & Son, Inc., Joseph T.
Sheffield Div. Armco Steel Corp.
Simonds Saw & Steel Co.
Stulz-Sickles Co.
Tennessee Coal & Iron Div. U. S. Steel Corp.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
Vanadium-Alloys Steel Co.
Wood Steel Co., Alan
Youngstown Sheet & Tube Co.

(STEEL MINE SUPPORTS & CIRCULAR SETS — see Mine Supports)

(STOWERS—see Concrete Pumps & Placers)

STUD DRIVERS

DuPont de Nemours & Co., E. I.
Thor Power Tool Co.

(SULPHUR WELL EQUIPMENT—see Salt & Sulphur)

SURVEYING EQUIPMENT & SUPPLIES—also see: Drafting Equipment & Supplies; Transits, Pocket

American Paulin System
Berger & Sons, C. L. Inc.
Black Diamond Spad Co.
Bruning Co., Inc. Charles
Brunson Instrument Co.
Geo-Optic Co., Inc.
Geophysical Instrument & Supply Co.
Gurley, W. & L. E.
KERN INSTRUMENTS, INC.
Keuffel & Esser Co.
Post Co., Frederick
Suverkrop Instruments
Warren-Knight Co.
White, Instrument Co., David.
Wild Heerbrugg Instruments, Inc.

(SURVEYORS—see Contractors)

T

(TACHOMETERS—see Meters, Speed)

TANKS, LINED—see below; also see: Coatings; Linings

Aluminum Co. of America
American Hard Rubber Co.
Arrow Tank Co.
Beall Pipe & Tank Corp.
Butler Mfg. Co.
Caldwell Co., W. E.
DENVER EQUIPMENT CO.
Gates Engrg. Co.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co.
Hauser-Stander Tank Co.
Heil Process Equipment Co.
Kirk & Blum Mfg. Co.
Patterson Foundry & Machine Co.
U. S. Rubber Co. Mechanical Goods Div.

TANKS, LINED, SPECIAL METAL

Aluminum Co. of America
Ampco Metal, Inc.
Arrow Tank Co.
Beall Pipe & Tank Corp.
Beech Aircraft Corp.
Caldwell Co., W. E.
Canadian Locomotive Co., Ltd.
Chattanooga Boiler & Tank Co.
Chicago Bridge & Iron Co.
Graver Tank & Mfg. Co., Inc.
Heil Process Equipment Co.
Kirk & Blum Mfg. Co.
Klemp Metal Grating Corp.
National Lead Co.
Process Engineering, Inc.
Yuba Consolidated Industries, Inc., California Steel Products Div.

TANKS, LINED, CERAMIC, CONCRETE, GLASS, ETC.

Beall Pipe & Tank Corp.
Butler Manufacturing Co.
Carrier Conveyor Corp.
Heil Process Equipment Co.
Marietta Concrete Corp.
Ogden Iron Works
Patterson Foundry & Machine Co.
Pennsalt Chemicals Corp.
Process Engineering, Inc.
Smith Co., A. O.
Thermoid Co. Industrial Div.

TANKS, LINED, PLASTIC OR RUBBER

American Hard Rubber Co.
Arrow Tank Co.
Beall Pipe & Tank Corp.
Booth Co.
Butler Mfg. Co.
Caldwell Co., W. E.
Canadian Locomotive Co., Ltd.
Chattanooga Boiler & Tank Co.
DENVER EQUIPMENT CO.
EIMCO CORP.
Gallagher Co.
Gates Engrg. Co.
Goodall Rubber Co.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co. Industrial Products
Graver Tank & Mfg. Co., Inc.
Heil Process Equipment Co.
Kirk & Blum Mfg. Co.
LINATEX CORP. OF AMERICA
Luzerne Rubber Co.
Marietta Concrete Corp.
Process Engineering, Inc.
Quaker Rubber Div. H. K. Porter Co. Inc.
STEARNS ROGER MFG. CO.
U. S. Rubber Co. Mechanical Goods Div.
Yaun Mfg. Co., Inc.

TANKS, STEEL—also see Bins

Beall Pipe & Tank Corp.
Bethlehem Steel Co., Inc.
Black, Sivalls & Bryson, Inc.
Bodinson Manufacturing Co., Inc.
Butler Manufacturing Co.
Caldwell Co., W. E.
Canadian Locomotive Co., Ltd.
Chattanooga Boiler & Tank Co.
Chicago Bridge & Iron Co.
Cochrane Corp.
Columbian Steel Tank Co.
Condenser Service & Engineering Co.
CONNELLSVILLE MFG. & MINE SUPPLY CO.
Daniels Co. Contractors, Inc.
DENVER EQUIPMENT CO.
Dominion Steel & Coal Corp., Ltd.
Engineered Equipment Inc.
Enterprise Wheel & Car Corp.
Erie Strayer Co.
General American Transportation Corp.
Graver Tank & Mfg. Co., Inc.
Heil Co.
Holmes & Bros., Inc. Robert
Industrial Engrg. & Construction Co.
Irwin Foundry & Mine Car Co.
Johnson Co., C. S.
Kaiser Steel Corp., Fabricating Div.
Kanawha Mfg. Co.
Keeler Co., E.
Kirk & Blum Mfg. Co.
Lakeside Bridge & Steel Co.
Mahon Co., R. C.
Ogden Iron Works
Ottumwa Box Car Loader Co.
Process Engineering, Inc.
SUN SHIPBUILDING & DRY DOCK CO.
STEARNS ROGER MFG. CO.
TREADWELL CO., N. H.
VULCAN IRON WORKS CO. (VULCAN-DENVER)
Wheeler Mfg. Co., C. H.
Yaun Mfg. Co., Inc.
Yuba Consolidated Industries, Inc., California Steel Products Div.

TANKS, WOOD — also see Bins

Acme Tank Mfg. Co.
Arrow Tank Co.
Atlantic Tank Corp.
Black, Sivalls & Bryson, Inc.
Caldwell Co., W. E.
DENVER EQUIPMENT CO.
Hall & Sons, Amos H.
Hauser-Stander Tank Co.
Morse Bros. Machinery Co.
National Tank & Pipe Co.
Pacific Wood Tank Corp.
Santa Fe Tank Div. Fluor Products Co.
Stulz-Sickles Co.
Windeler Co., Ltd., George

(TANK LEVEL INDICATORS —see: Bin & Tank Level Indicators)

TARPAULINS & TENTING

AMERICAN BRATTICE CLOTH CORP.
Daniels, Inc., C. R.
Fulton Bag & Products Co.
Goodrich Industrial Products Co., B. F.
Irvington Div. Minnesota Mining & Mfg. Co.
Parker Safety Equipment Co.
Paulsen-Webber Cordage Corp.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Safety Clothing & Equipment Co.
Snyder & Sinn, Inc., M. L.
Turner Halsey Co.

(TELEPHONES— see Communications)

(TELEVISION— see Communications)

(THERMOMETERS & THERMOCOUPLES — see Meters, Temperature)

THICKENERS — also see: Classifiers; Filters; Separators; Screens

Dagley Mfg. Co.
DENVER EQUIPMENT CO.
DIESEL ENERGY CORP.
Dorr-Oliver, Inc.
EIMCO CORP.
Graver Water Conditioning Co.
HARDINGE CO., INC.
Heyl & Patterson, Inc.
Hirsch Bros. Machy. Co.
Infilco, Inc.
Kennedy-Van Saun Mfg. & Eng. Corp.
LINK-BELT CO.
MACHINERY CENTER INC.
Morse Bros. Machinery Co.
Shriver & Co., T.
WESTERN MACHINERY CO.

(TIMBER CONNECTORS, SPECIAL — does not include Fasteners)

TIMBER FRAMING MACHINES

DENVER EQUIPMENT CO.
STEARNS ROGER MFG. CO.
Timber Engineering Co.

TIMBER PRESERVATIVES

Baxter & Co., J. H.
C—A Wood Preserver Co.
Carbolineum Wood Preserving Co.
Coal Chem. Div., U. S. Steel Corp.
Darworth, Inc.
Dow Chemical Co.
DuPon de Nemours & Co., E. I.
Koppers Co. Inc.
Osmose Wood Preserving Co.
Quigley Co., Inc.
Reilly Tar & Chemical Corp.

TIMBERING MACHINES

Fletcher & Co., J. H.
Goodman Mfg. Co.

TIRES & TUBES

Armstrong Rubber Co.
Gates Rubber Co.
Goodrich Co., B. F. Truck & Bus Tire Dept.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co. Industrial Products
Seiberling Rubber Co.
U. S. Rubber Co.

TOOLS, HAND, & HAND-HELD POWER TOOLS — does not include: Car Detrailers & Rerailers; Car Movers, Hand; Hoists, Lift, Hand Chain; Jacks; Rail Benders; Track Gage-Rods & Levels; Shop Equipment, Powered (Lathes, etc.); Lubricating Equipment; Car Wheel & Gear Pullers; Concrete Placers; Kiln & Industrial Guns; Stud Drivers; Rail Drills & Punches; Timbering Machines; Geologist's Equip.; Welding & Cutting Equip.; Burners; Instruments; Meters & Gages

Ames Co., O.
Ampco Metal, Inc.
Black & Decker Mfg. Co.
BRUNNER & LAY ROCK 'BIT OF PHILADELPHIA, INC.
Burndy Corp.
Chicago Pneumatic Tool Co.
Dicke Tool Co.
Electric Materials Co.
GARDNER-DENVER CO.
General Steel Warehouse Co., Inc.
Glensco Tool Div.
Gibraltar Equipment & Mfg. Co.
Graybar Elec. Co., Inc.
Greene, Tweed & Co.
Herold Mfg. Co.
Ideal Industries, Inc.
INGERSOLL-RAND CO.
Interstate Drop Forge Co.
Leavitt Machine Co.
Leetonia Tool Co.
Long Co.
Lufkin Rule Co.
Milwaukee Electric Tool Corp.
Nelson Stud Welding
Newcomer Products, Inc.
Owatonna Tool Co.
Patton Mfg. Co., Inc.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Porter-Cable Machine Co.
Proto Tool Co.
Reed Roller Bit Co.
Remington Arms Co. Inc.
Simonds Saw and Steel Co.
Skookum Co., Inc.
Snap-on-Tools Corp.
Stanley Electric Tool Div. Stanley Works
Star Expansion
Swett Iron Works, A. L.
Syntron Co.
Thor Power Tool Co.
Toledo Pipe Threading Machine Co.
U. S. Electrical Tool Co.
VULCAN IRON WORKS CO. (VULCAN-DENVER)
Willey's Carbide Tool Co.
Wodack Electric Tool Corp.
Wood Shovel & Tool Co.
Wright Power Saw & Tool Corp. Subsidiary of Thomas Industries

(TOOLS, POWER — see above or Shop Equipment)

(TORQUE CONVERTERS—see Drives)

(TOWERS, EXTENSIBLE & MOBILE—see Booms)

(TRACK—see below; also see Rail)

TRACK CLEANING MACHINES

AMERICAN MINE DOOR CO.
Athey Products Corp.
Frank, M. K.
Hough Co., Frank G.
NORDBERG MFG. CO.

TRACK GAGE-RODS & LEVELS

Aldon Co.
Coover Railroad Track Brace Co.
Foster Co., L. B.
Frank, M. K.
Gibraltar Equipment & Mfg. Co.
NORDBERG MFG. CO.

TRACK SHIFTER, LAYING & OTHER MACHINES

Frank, M. K.
NORDBERG MFG. CO
Templeton, Kenly & Co.

TRACTORS, CRAWLER

Allis-Chalmers Mfg. Co.
Case Co., J. I.
Caterpillar Tractor Co.
EIMCO CORP.
Euclid Div. General Motors Corp.
Hough Co., Frank G.
International Harvester Export Co.
Joy Mfg. Co.
MACHINERY CENTER, INC.
Oliver Corp.
Schroeder Brothers Corp.

TRACTORS, WHEELED—does not include Truck Tractors; also see Car Movers

Allis-Chalmers Mfg. Co.
American Coleman Co.
Caterpillar Tractor Co.
Deere Co., John
Easton Car & Construction Co.
Four Wheel Drive Auto Co.
Hough Co., Frank G.
International Harvester Export Co.
LE TOURNEAU-WESTINGHOUSE CO.
LeTourneau, Inc., R. G.
Napco Industries Inc.
Oliver Corp.
Pettibone Mulliken Corp.
Sheppard Co., Inc., R. H.
Silent Hoist & Crane Corp.
TRACTOMOTIVE CORP.
Westinghouse Air Brake Co.

TRACTOR ATTACHMENTS —also see Loaders

Allis-Chalmers Mfg. Co. Construction Machy. Div.
American Tractor Equipment Corp.
Anthony Co.
Arrow Mfg. Co.
Ateco Div. Greenville Steel Car Co.
Balderson Inc.
Case Co., J. I. Industrial Div.
Caterpillar Tractor Co.
Clark Equipment Co. Construction Machinery Div.
Drott Mfg. Co.
EIMCO CORP.
Electric Steel Foundry Co.
Gar Wood Industries, Inc.
Hales Co., W. M.
Hough Co., Frank G.
Hyster Co.
International Harvester Export Co.
Joy Mfg. Co.
LE TOURNEAU-WESTINGHOUSE CO.
MACHINERY CENTER, INC.
Oliver Corp.
Preco, Inc.
Skookum Co., Inc.
TRACTOMOTIVE CORP.
Westinghouse Air Brake Co.

TRACTOR & EARTHMOVING EQUIPMENT WEAR-REPLACEMENT PARTS

Allis-Chalmers Mfg. Co. Construction Machy. Div.
Alloy Steel & Metals Co.
American Brake Shoe Co. American Manganese Steel Div.
Case Co., J. I. Industrial Div.
Caterpillar Tractor Co.
Continental Copper & Steel Industries Inc. Wooldridge Div.
EIMCO CORP.
Electric Steel Foundry Co.
Frog, Switch & Mfg. Co.
Gar Wood Industries, Inc.
Gatke Corp.
Euclid Div. General Motors Corp.
Hales Co., W. M.
Kensington Steel Div., Poor & Co.
MACHINERY CENTER INC.
Oliver Corp.
Rockwell Spring & Axle Co. Timken-Detroit Axle Div.
Sorel Steel Foundries, Ltd.
Sterling Steel Casting Co.
Thew Shovel Co.
Tool Steel Gear & Pinion Co.
U. S. Rubber Co.
Wellman Co., S. K.

TRAILERS & WAGONS FOR MOTORTRUCK & TRACTOR — also see: Scrapers; Trucks & Trailers, Special Self-Loading

Allis-Chalmers Mfg. Co. Construction Machy. Div.
Anthony Co.
Arrow Mfg. Co.
Athey Products Corp.
Beall Pipe & Tank Corp.
C & D Div. Yuba Consolidated Industries, Inc.
Cline Truck Co.
Continental Copper & Steel Industries Inc. Wooldridge Div.
Easton Car & Construction Co.
Euclid Div. General Motors Corp.
F. A. B. Mfg. Co.
Fairbanks Co.
Four Wheel Drive Auto Co.
Fruehauf Trailer Co.
Hendrickson Mfg. Co.
International Harvester Export Co.
Irwin Foundry & Mine Car Co.
LE TOURNEAU-WESTINGHOUSE CO.
Maxi Corp.
ROGERS BROTHERS CORP.
Salem-Brosius, Inc.
Schonrock Mfg. Co.
Truck Engineering Corp.
WINTER WEISS CO.

TRAMP IRON DETECTORS

ASEA ELECTRIC INC.
General Equipment & Mfg. Co.
INDUSTRIAL PHYSICS & ELECTRONICS CO.

TRANSITS, POCKET

AINSWORTH & SONS, WILLIAM
Bruning Co., Inc. Charles
Engineers Syndicate, Ltd.
Geo-Optic Co., Inc.
Geophysical Instrument & Supply Co.
Keuffel & Esser Co.
Suverkrop Instruments

(TRANSMISSIONS —see Drives)

(TRAPS—see Pipeline Traps)

(TROLLEY (ELECTRICAL HAULAGE) ACCESSORIES —see Electric Trolley Accessories)

TRUCKS (MOTOR) & TRUCK TRACTORS—also see below and: Scrapers; Trailers

American Coleman Co.
Chrysler Corp. Dodge Truck Div.
Cline Truck Co.
Continental Copper & Steel Industries Inc. Wooldridge Div.
F. A. B. Mfg. Co.
Four Wheel Drive Auto Co.
Euclid Div. General Motors Corp.
Federal Motor Truck Div. Napco Industries Inc.
Ford Motor Co.
Getman Brothers
Hendrickson Mfg. Co.
International Harvester Co. Motor Truck Div.
International Harvester Export Co.
Koehring Div. of Koehring Co.
KW-DART TRUCK CO.
LE TOURNEAU-WESTINGHOUSE CO.
MACK TRUCKS, INC.
Marmon-Herrington Co.
Oshkosh Motor Truck, Inc.
Reo Motors, Inc.
Walter Motor Truck Co.
Westinghouse Air Brake Co.
Willys Motors, Inc.

TRUCKS, LIFT, FORK & PLATFORM

Allis-Chalmers Mfg. Co. Engine-Material Handling Div.
American Pulley Co.
Baker-Raulang Co.
Easton Car & Construction Co.
Four Wheel Drive Auto Co.
Hyster Co.
Kwik-Mix Co., Koehring Div.
Lamson Corp.
LeTourneau, Inc., R. G.
Oliver Corp.
Prime Mover Co.
Silent Hoist & Crane Corp.
Uhrden, Inc.

Yale & Towne Mfg. Co. Yale Materials Handling Div.

TRUCKS, SHUTTLE CAR & BUGGIE TYPE

Atlas Car & Mfg. Co.
Atlas Copco
Easton Car & Construction Co.
Electric Steel Foundry Co.
Getman Brothers
Goodman Mfg. Co.
Herold Mfg. Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Koehring Div. of Koehring Co.
KW-DART TRUCK CO.
National Mine Service Co.
Salem-Brosius, Inc.
Yuba Consolidated Industries, Inc., Yuba Mining Div.

TRUCKS & TRAILERS, SPECIAL SELF-LOADING — does not include Scrapers or units with load moving devices alone

Atlas Copco
Sanford Day Iron Works

(TRUCK TRAILERS—see Trailers)

TRUCK & TRAILER BODIES

Anthony Co.
Beall Pipe & Tank Corp.
Butler Manufacturing Co.
Cline Truck Co.
Easton Car & Construction Co.
Galion Allsteel Body Co.
Gar Wood Industries, Inc.
Gramm Trailer Corp.
Heil Co.
Hercules Steel Products Co.
Hockensmith Corp.
International Harvester Export Co.
Landis Steel Co.
Marion Metal Products Co.
Schonrock Mfg. Co.
Transport Trailers, Inc.
Truck Engineering Corp.
WINTER WEISS CO.

(TRUCK & TRAILER DUMPING DEVICES—see Car (& Truck) Dumping Devices)

(TUBING, METAL—see Pipe)

(TURBINES—see Engines)

U

ULTRAVIOLET LIGHTS

CARPCO MANUFACTURING, INC.
Detectron Corp.
Engineers Syndicate, Ltd.
Fisher Research Laboratory, Inc.
Geophysical Instrument & Supply Co.
Macbeth Daylighting Corp.
Menlo Research Laboratory
Mt. Sopris Instrument Co.
Ultra-Violet Products, Inc.
Whites Electronics

UNLOADERS, R. R., CAR & TRUCK

Barber-Greene Co.
Conveyor, Inc.
Dravo Corp.
Easton Car & Construction Co.
Erie Strayer Co.
Frank, M. K.
General American Transportation Corp.
HEWITT-ROBINS, INC.
Heyl & Patterson, Inc.
Hough Co., Frank G.
Jeffrey Mfg. Co.
LINK-BELT CO.
Lippmann Engineering Works, Inc.
McKiernan-Terry Corp., Mead Morrison Div.
Oliver Corp. A. B. Farquhar Div.
Richardson Scale Co.
Stephens-Adamson Mfg. Co.
Webster Mfg., Inc.

V

VALVES

Alco Products, Inc.
ALLEN-SHERMAN-HOFF PUMP CO.
American Chain & Cable Co., Inc. R-P&C Valve Div.
American Hard Rubber Co.
Anker-Holth Div., Wellman Engineering Co.
Automatic Switch Co.
Bailey Meter Co.
Barksdale Valves
Barrett Haentjens & Co.
Black, Sivalls & Bryson, Inc.
Bristol Co.
Builders-Providence, Div. B-I-F Industries
Cash Co., A. W.
Clark Controller Co.
Cochrane Corp.
Conrader Co., Inc., R.
Corning Glass Works, Plant Equipment Dept.
Crane Co.
Crosby Valve & Gage Co.
Cutler-Hammer, Inc.
Darling Valve & Mfg. Co.
DeZurik Corp.
Dick Co., R. & J.
Dixon Valve & Coupling Co.
Duriron Co., Inc.
Edward Valves, Inc.
Electric Steel Foundry Co.
Elkhart Brass Mfg. Co., Inc.
EQUIPMENT ENGINEERS INC.
Everlasting Valve Co.
Fairbanks Co.
Falcon Alarm Co., Inc.
Farris Flexible Valve Corp.
Fisher & Porter Co.
Foster Co., L. B.
Foxboro Co.
Galland Henning Mfg. Co. Nopak Div.
Golden-Anderson Valve Specialty Co.
Goodrich Industrial Products Co., B. F.
Goyne Pump Co.
Grinnell Co., Inc.
Hamer Valves, Inc.
HEWITT-ROBINS, INC.
Hills-McCanna Co.
Hunt & Son, Inc., C. B.
Jenkins Bros.
Johnson Corp.
Jordan Corp., Div. OPW Corp.
Kennedy Valve Mfg. Co.
Kieley & Mueller, Inc.
Klipfel Valves, Inc.
Kobe, Inc.
Ladish Co., Hasco Div.
Ledeen, Inc.
LE-HI Div. Hose Accessories Co.
LINATEX CORP. OF AMERICA
Lonergan Co., J. E.
Lunkenheimer Co.
Luzerne Rubber Co.
McDonald Mfg. Co., A. Y.
McNally Pittsburg Mfg. Corp.
Meckum Engineering, Inc.
Minneapolis-Honeywell Regulator Co. Industrial Div.
MINE & SMELTER SUPPLY CO., MFG. DIV.
Mission Mfg. Co.
Mueller Brass Co.
Ohio Brass Co.
Ohio Injector Co.
Oilgear Co.
Okadee Co.
Pennsylvania Pump & Compressor Co.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Powell Co., Wm.
Red Jacket Co., Inc.
Republic Flow Meters Co.
Rockwell Mfg. Co.
Rockwell Co., W. S.
Stockham Valves & Fittings
U. S. Rubber Co.
U. S. Rubber Co. Mechanical Goods Div.
Vickers Inc.
Walworth Co.
Weatherhead Co. Fort Wayne Div.
Western Precipitation Corp.
Westinghouse Air Brake Co., Ind. Products Div.
Weston Electrical Instrument Corp. Subsidiary of Daystrom, Inc.
Wilkerson Corp.
Yarnall-Waring Co.

VALVE OPERATING MECHANISMS—does not include Controls

Bristol Co.
Cash Co., A. W.
Darling Valve Mfg. Co.
DeZurik Corp.
Falcon Alarm Co., Inc.
Foxboro Co.
Kieley Mueller, Inc.
Ledeen, Inc.
Limitorque Corp.
Minneapolis-Honeywell Regulator Co.
Ohio Injector Co.
Okadee Co.
Philadelphia Gear Works
Republic Flow Meters Co.
Wheeler Mfg. Co., C. H.
Wilkerson Corp.

VENTILATION TUBING, NON-METALLIC — does not include Pipe, Ventilation

Acme Rubber Mfg. Co.
AMERICAN BRATTICE CLOTH CORP.
Bemis Bro. Bag Co.
DuPont de Nemours & Co., E. I.
DuPont de Nemours Co., Inc. E. I. Explosives Dept.
DuPont de Nemours Co., Inc. E. I. Fabrics Div.
Flexaust Co.
Flexible Tubing Co.
Hamilton Rubber Mfg. Corp.
U. S. Rubber Co. Mechanical Goods Div.

VIBRATORS & VIBRATING MECHANISMS — also see: Car Shakers; Screen Eccentrics

BIN-DICATOR CO.
Branford Co.
Cleveland Vibrator Co.
Davis Foundry & Machine Works
DIESEL ENERGY CORP.
Eriez Mfg. Co.
Hack Engineering Co.
HEWITT-ROBINS, INC.
Lecco Machinery & Engineering Co.
LINK-BELT CO.
Lippmann Engineering Works, Inc.
Martin Engineering Co.
Southwestern Industrial Electronics Co.
Syntron Co.
Tyler Co., W. S.
Universal Dredge Mfg. Co.

W

(WAGON DRILLS—see Drills)

(WAGONS — see: Trailers; Cars, Mine)

(WASHERS, MINERAL (LOG, PUG, ETC.) — see Scrubbers)

WASHING PLANTS, SAND & GRAVEL, COMPLETE, MOBILE & PORTABLE

Baldwin-Lima-Hamilton Corp. Construction Equipment Div.
Bodinson Manufacturing Co., Inc.
Daniels Co. Contractors, Inc.
Davis Foundry Machine Works
DENVER EQUIPMENT CO.
Diamond Iron Works Div. Goodman Mfg. Co.
Eagle Iron Works
Fuel Process Co.
Heyl & Patterson, Inc.
IOWA MFG. CO.
Lippman Engineering Works, Inc.
McLanahan & Stone Corp.
Pioneer Engineering Div. Poor & Co. Inc.
Rogers Iron Works Co.
Smith Engineering Works
Universal Engineering Corp.
Washington Machinery Co.
WESTERN MACHINERY CO.
Yuba Consolidated Industries, Inc., Yuba Mining Div.

WATER CLARIFICATION & TREATMENT EQUIPMENT —also see Ion Exchange

Allis-Chalmers Mfg. Co. Industries Group
American Water Softener Co.
American Well Works
Bird Machine Co.
Brosites Products Corp.
Builders-Providence Div. B-I-F Industries
Chain Belt Co.
Christian Engineers, J. D.
Cochrane Corp.
Daniels Co. Contractors, Inc.
DENVER EQUIPMENT CO.
Dorr Oliver, Inc.
EIMCO CORP
Enley Products, Inc.
Fischer & Porter Co.
Graver Water Conditioning Co.
Hagan Chemicals & Controls, Inc. Divisions: Calgon Co., Hall Laboratories
HARDINGE CO., INC.
Infilco, Inc.
Ionics, Inc.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Leeds & Northrup Co.
LINK-BELT CO.
Mallinckrodt Chemical Works
Omega Machine Co., Div. B-I-F Industries
Permutit Co., Div. Pfaudler Permutit Inc.
Shriver & Co., T.
Taylor & Co., W. A.
WESTERN MACHINERY CO.
Zurn Mfg., J. A., Div. Zurn Industries, Inc.

WATER CLARIFICATION & TREATMENT CHEMICALS —does not include Ion Exchange Resins

Allis-Chalmers Mfg. Co. Industries Group
AMERICAN CYANAMID CO., EXPLOSIVES & MINING CHEMICALS DEPT.
American Sand-Banum Co., Inc.
Armour Chemical Div.
Baker & Adamson Products, General Chemical Div., Allied Chemical Corp.
Butler Bin Co.
Canadian Industries Ltd.
Cochrane Corp.
Cyanamid International, Mining Chemicals Dept.
Dow Chemical Co.
DuPont de Nemours & Co., E. I.
Food Machinery & Chemical Corp. Westvaco Mineral Products Div. Westvaco Chlor-Alkali Div.
Goodrich, B. F. Co.
Hagan Chemicals & Controls, Inc. Divisions: Calgon Co., Hall Laboratories
HERCULES POWDER CO.
Marathon Corp. Chemical Sales Dept.
MONSANTO CHEMICAL CO.
Pacific Lumber Co.
Pennsalt Chemicals Corp.
Permutit Co., Div. Pfaudler Permutit Inc.
Pettinos, Inc., George F.
Philadelphia Quartz Co.
Stein, Hall & Co., Inc.
Union Carbide Chemicals Co., Union Carbide Corp.
Van Waters & Rogers, Inc.
West Virginia Pulp & Paper Co.
Wyandotte Chemicals Corp.
Zurn Mfg., J. A., Div. Zurn Industries, Inc.

(WEIGH HOPPERS — see Scales)

WELDING & CUTTING EQUIPMENT — does not include Metallizing Equipment

Air Reduction Sales Co., Div. Air Reduction Co., Inc.
American Brake Shoe Co. American Managanese Steel Div.
Caterpillar Tractor Co.
Daniels, Inc., C. R.
Eisler Engineering Co.
Gar Wood Industries, Inc.
HARNISCHFEGER CORP.
Hobart Bros. Co.
Industrial Air Products Co.
Kaiser Aluminum & Chemical Sales, Inc.
Kurz & Root Co.
Lincoln Electric Co.
Linde Co. Union Carbide Corp.
Marquette Mfg. Co., Inc.
Metal & Thermit Corp.
National Cylinder Gas Co.
Ohio Brass Co.
Parker Safety Equipment Co.
Phoenix Products Co.
Sellstrom Mfg. Co.
Sight Feed Generator Co.
Smith Co., A. O.
Smith Welding Equipment Corp.
Tweco Products, Inc.
Universal Electric Sales Corp.
VICTOR EQUIPMENT CO., ALLOY ROD & METAL DIV.

Wall Colmonoy Corp.
Westinghouse Electric Corp.
Worthington Corp.

WELDING RODS, ELECTRODES, SOLDER, ETC. — also see: Hardfacing; Metallizing Supplies

Air Reduction Sales Co., Div. Air Reduction Co., Inc.
All-State Welding Alloys Co., Inc.
Alloy Rods Co.
American Brake Shoe Co. American Managanese Steel Div.
American Brass Co.
American Chain & Cable Co., Inc. Page Steel & Wire Div.
Arcos Corp.
Coast Metals, Inc.
CRUCIBLE STEEL CO. OF AMERICA
Eisler Engineering Co.
Englehard Industries Inc.
Eutectic Welding Alloys Corp.
HARNISCHFEGER CORP.
Haynes Stellite Co. Div. Union Carbide Corp.
Hobart Bros. Co.
Industrial Air Products Co.
Industrial Overlay Metals, Inc.
International Nickel Co.
Lincoln Electric Co.
Linde Co. Union Carbide Corp.
Marquette Mfg. Co., Inc.
Metal & Thermit Corp.
Mueller Brass Co.
National Carbon Co. Div. Union Carbide Corp.
National Cylinder Gas Co.
Ohio Carbon Co.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Revere Copper & Brass, Inc.
Sheffield Div. Armco Steel Corp.
Sight Feed Generator Co.
Smith Co., A. O.
Stackpole Carbon Co.
Stoody Co.
Stulz-Sickies Co.
Sylvania Electric Products Inc., Chemical & Metallurgical Div.
Titan Metal Mfg. Co.
U. S. Gauge Div., American Machine & Metal, Inc.
Vanadium-Alloys Steel Co.
VICTOR EQUIPMENT CO. ALLOY ROD & METAL DIV.
Westinghouse Electric Corp.

WELDMENTS — also see: Bucket Teeth; Castings; Forgings; Tractor Wear-Replacement Parts

Alco Products, Inc.
American Brake Shoe Co. American Managanese Steel Div.
Chattanooga Boiler & Tank Co.
COLORADO FUEL & IRON CORP.
CONNELLSVILLE MFG. & MINE SUPPLY CO.
FALK CORP.
Farrell-Cheek Steel Co.
General American Transportation Corp.
Graver Tank & Mfg. Co., Inc.
Industrial Air Products Co.
Industrial Overlay Metals, Inc.
Irwin Foundry & Mine Car Co.
Kirk & Blum Mfg. Co.
Kensington Steel Div., Poor Co.
Lakeside Bridge & Steel Co.
Lukens Steel Co.
Mahon Co., R. C.
Manning, Maxwell & Moore, Inc. Shaw Box Crane & Hoist Div.
Meckum Engineering, Inc.
NATIONAL IRON CO.
NORDBERG MFG. CO.
Pollock Co., William B.
Sight Feed Generator Co.
Smith Co., A. O.
Sorel Steel Foundries, Ltd
Wheeler Mfg. Co., C. H.

(WHEELS—see Car (& Locomotive) Wheels)

(WINCHES, WINDERS & HOISTS—see below; also see: Car Movers, Winch Types; Hoists)

WINCHES, AIR

American Hoist & Derrick Co.
Atlas Copco Eastern, Inc.
Atlas Copco Pacific, Inc.
Chicago Pneumatic Tool Co.
GARDNER-DENVER CO.
Holman Bros.—Canada Ltd.
INGERSOLL-RAND CO.
Joy Mfg. Co.
Lidgerwood Industries, Inc.
MACHINERY CENTER INC.
Silent Hoist & Crane Corp.

WINCHES, DIESEL & GASOLINE

American Hoist & Derrick Co.
Chicago Pneumatic Tool Co.
Clyde Iron Works, Inc.
Gar Wood Industries, Inc.
INGERSOLL-RAND CO.
Joy Mfg. Co.
Lidgerwood Industries, Inc.
O. K. Machinery Div. John C. Motter Printing Press Co.
Silent Hoist & Crane Corp.
Superior-Lidgerwood-Mundy Corp.

WINCHES, ELECTRIC

American Hoist & Derrick Co.
Christian Engineers, J. D.
Clyde Iron Works, Inc.
Easton Car & Construction Co.
Electro Lift, Inc.
Gar Wood Industries, Inc.
HARNISCHFEGER CORP.
INGERSOLL-RAND CO.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Lidgerwood Industries, Inc.
LINK-BELT CO.
Manning, Maxwell & Moore, Inc. Shaw Box Crane & Hoist Div.
Moran Engineering Co.
O. K. Machinery Div. John C. Motter Printing Press Co.
Reading Crane & Hoist Corp.
Round & Sons, Inc., David
Sanford-Day Iron Works, Inc.
SAUERMAN BROS., INC.
Shepard Niles Crane & Hoist Corp.
Silent Hoist & Crane Corp.
Stephens-Adamson Mfg. Co.
Stimmel Winch Co., Inc.
Superior-Lidgerwood-Mundy Corp.
VULCAN IRON WORKS CO. (VULCAN-DENVER
Washington Iron Works
Yale & Towne Mfg. Co.
Yuba Consolidated Industries, Inc., Yuba Mfg. Div.

WINCHES, HAND—does not include Hoists, Lift, Hand Chain

Bartlett & Snow Co., C. O.
Christian Engineers, J. D.
Griphoist, Inc.
Indiana Foundry Co.
LINK-BELT CO.
Round & Son, Inc., David
Stephens-Adamson Mfg. Co.
Stimmel Winch Co., Inc.
Yale & Towne Mfg. Co.

WINCHES, HYDRAULIC

American Hoist & Derrick Co.
AUSTIN-WESTERN CONSTRUCTION EQUIPMENT DIV. BALDWIN-LIMA-HAMILTON CORP.
Case Co., J. I. Industrial Div.
Lidgerwood Industries, Inc.
Manganese Steel Forge Co.
Manning, Maxwell & Moore, Inc. Shaw Box Crane & Hoist Div.
Moran Engineering Co.
Mt. Sopris Instrument Co.
Silent Hoist & Crane Corp.
Star Wire Screen & Iron Works, Inc.
Superior-Ligerwood-Mundy Corp.
Vickers, Inc.

WINCHES, PORTABLE & MOVABLE

Chicago Pneumatic Tool Co.
Christian Engineers, J. D.
Joy Mfg. Co.
Sanford-Day Iron Works, Inc.

WINCHES, STATIONARY

Christian Engineers, J. D.
Joy Mfg. Co.
Sanford-Day Iron Works, Inc.

WIRE CLOTH

Bonded Scale & Machine Co.
Buffalo Wire Works Co.
Cambridge Wire Cloth Co.
Chase Brass & Cooper Co.
COLORADO FUEL & IRON CORP.
HEWITT-ROBINS, INC.
Hoyt Wire Cloth Co.
Ludlow-Saylor Wire Cloth Co.
Multi-Metal Wire Cloth Co., Inc.
Newark Wire Cloth Co.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Pioneer Engineering Div. Poor & Co. Inc.
Simplicity Engineering Co.
Southwestern Engineering Co.
Tyler Co., W. S.
Wickwire Spencer Steel Div., Colorado Fuel & Iron Corp.

WIRE FENCING—see Fencing

WIRE ROPE

American Chain & Cable Co. American Cable Div.
American Chain & Cable Co., Inc. Automotive & Aircraft Div.
American Chain & Cable Co. Hazard Wire Rope Div.
American Steel & Wire Div. U.S. Steel Corp.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Broderick & Bascom Rope Co.
Chase Brass & Copper Co.
COLORADO FUEL & IRON CORP.
Electric Steel Foundry Co.
Hales Co., W. M.
Jones & Laughlin Steel Corp.
Leschen Wire Rope Div. H. K. Porter Company, Inc.
Macwhyte Wire Rope Co.
National Mine Service Co.
Pacific Wire Rope Co.
Paulsen-Webber Cordage Corp.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Rochester Ropes, Inc.
Roebling's Sons Corp., John A. Subsidiary of Colorado Fuel & Iron Co.
Ryerson & Son, Inc., Joseph T.
SAUERMAN BROS. INC.
Tennessee Coal & Iron Div. U. S. Steel Corp.
TEXAS CO.
Union Wire Rope Corp., Subsidiary Armco Steel Corp.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
Westinghouse Air Brake Co.
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.
Wire Rope Corp. of America, Inc.
Yara Engineering Corp. Interstate Equipment Div.

(WIRE ROPE DRESSING—see Lubricants)

WIRE ROPE FITTINGS

American Chain & Cable Co. American Cable Div.
American Chain & Cable Co. Hazard Wire Rope Div.
American Hoist & Derrick Co.
American Steel & Wire Div. U. S. Steel Corp.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Broderick & Bascom Rope Co.
COLORADO FUEL & IRON CORP.
Electric Steel Foundry Co.
Farrell-Cheek Steel Co.
Hales Co., W. M.
Hayes Steel Products, Ltd.
Holmes & Bros., Inc. Robert
Interstate Drop Forge Co.
Jones & Laughlin Steel Corp.
Lamson & Sessions Co.
Leschen Wire Rope Div. H. K. Porter Company, Inc.
Macwhyte Wire Rope Co.
Madesco Tackle Block Co.
National Mine Service Co.
Pacific Wire Rope Co.
Page Engineering Co.
Paulsen-Webber Cordage Corp.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Quay Industries
Rochester Ropes, Inc.
Roebling's Sons Corp., John A. Subsidiary of Colorado Fuel & Iron Co.
Ryerson & Son, Inc., Joseph T.
SAUERMAN BROS., INC.
Skookum Co., Inc.
Tennessee Coal & Iron Div. U. S. Steel Corp.
Union Wire Rope Corp. Subsidiary of Armco Steel Corp.
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.
Wire Rope Corp. of America, Inc.
Yara Engineering Corp. Interstate Equipment Div.

WIRE ROPE SLINGS

American Chain & Cable Co. American Cable Div.
American Chain & Cable Co. Hazard Wire Rope Div.
American Steel & Wire Div. U. S. Steel Corp.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Broderick & Bascom Rope Co.
Cambridge Wire Cloth Co.
COLORADO FUEL & IRON CORP.
Electric Steel Foundry Co.
Hales Co., W. M.
Jones & Laughlin Steel Corp.
Leschen Wire Rope Div. H. K. Porter Company, Inc.
Macwhyte Wire Rope Co.
McMillan's Sons, W. H.
Pacific Wire Rope Co.
Paulsen-Webber Cordage Corp.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Rochester Ropes, Inc.
Roebling's Sons Corp., John A. Subsidiary of Colorado Fuel & Iron Corp.
Ryerson & Son, Inc., Joseph T.
Tennessee Coal & Iron Div. U. S. Steel Corp.
Union Wire Rope Corp., Subsidiary Armco Steel Corp.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.
Wire Rope Corp. of America, Inc.

(WIRE SCREEN—see Screen)

(YIELDABLE PROPS & ARCHES—see: Mine Supports)

Part 2. Manufacturers' Index Starts on p 244

(Continued from p 7)

Drilling and blasting data for various types of metal and nonmetallic open pit mines (table) 1955: 50
Earthmoving—bigger units call for better handling ..... 1954: G 34

How to plan and develop an open-pit mine George Huseman 1955. 45
List of open pit blasthole drills and specifications aids selection (table) 1957: 72
New choices for better haulage ..... 1954: G 58

New drilling methods 1956: 60
Panorama of earthmoving equipment (charts & tables) 1956: 39
Planned maintenance pays ..... 1954: G 82

Planning the pit (map) ..... 1954: G 3

Stripping faster ..... 1954: G 36

Two-way radios speed open-pit work ..... 1954: G 136

Personnel & Public Relations also see: Safety
The Mine Office: tools and techniques 1958: 29

Phosphate
How belt concentrators recover phosphate at Coronet (flowsheet) 1958: 76
How fluidization can serve the mineral industries T. B. Counselman 1955: 70

Placer Mining & Dredging also see: Shops
Panorama of earthmoving equipment (charts & tables) 1956: 39

Power & Power Equipment also see: Shops
Air power for drills ..... 1954: G 30

Diesel power depended upon by many isolated mines (chart) ..... 1954: G 120

How six basic types of modern compressors operate 1957: 59
How the torque converter can help the open pit operator (charts) ..... 1954: G 124

How to safeguard your equipment operators (charts) ..... 1954: G 116

Improvements in diesel engine design 1957: 128
Indian Creek's electrical system C. K. Bain 1955: 77
Is mining making full use of modern electrical equipment and engineering? E. H. Tucker 1955: 80
The Mine Office: tools and techniques 1958: 29
Mine power: conductors and circuits 1958: 36
New units that promise better mechanical power transmission 1957: 134
Pit power cables (chart) ..... 1954: G 116

Power factor in the pit (charts) ..... 1954: G 130

Progress in motor design for mining 1957: 124
Proper grounding insures safety in the pit (charts) ..... 1954: G 114

What's available in air compressors 1957: 58

Processing also see: Beneficiating; Refining, Non-Metallics; Metallurgy, Extractive
Dust and fume collecting—misfit installations unnecessary (chart & table) 1956: 140
Facts about filter fabric 1957: 99
For better metallurgy—a checklist of solids-gas contacting equipment 1957: 106
How cyclones perform—case histories from the mining industry 1957: 90
How fluidization can serve the mineral industries T. B. Counselman 1955: 70
How metals are recovered (table) 1958: 66
How to get the most out of a wet cyclone 1957: 86

Is mining making full use of modern electrical equipment and engineering? E. H. Tucker 1955: 80
Metallurgical types of uranium ore (table) 1955: 94
Refresher on refractories 1956: 136
Scales in mining: a survey 1958: 62
Separating solids from liquids 1956: 117
Separating solids from solids (chart) 1956: 103
Solvent extraction—liquid-liquid separation 1957: 104
Try ion exchange for complex ores (tables) 1956: 133
Use this table to narrow down your dust collector choice 1957: 100
Vacuum and pressure filters for concentrate and process water (tables) 1957: 96

Pyrolytic Processing
At Reserve it's a downdraft continuous grate furnace 1957: 112
Erie does pelletizing in shaft furnaces 1957: 114
For better metallurgy—a checklist of solids-gas contacting equipment 1957: 106
Growing art of agglomeration 1957: 112
How fluidization can serve the mineral industries T. B. Counselman 1955: 70
International Nickel Co. smelter now and then 1958: 94
Lurgi process combines up and downdraft sintering 1957: 112
Marquette uses an updraft-downdraft sintering machine 1957: 114
Refresher on refractories 1956: 136
Smelting cobalt-silver ores at Deloro (flowsheet) 1958: 89

Safety & Health also see: Personnel (housing, welfare, etc.)
Butte combines gravity and slushing 1957: 48
Climax scrapes below unusual undercut 1957: 44

Dust and fume collecting—misfit installations unnecessary (chart & table) 1956: 140
Fan types and their operating principles (tables) 1957: 54
How to safeguard mill and smelter workers 1957: 67

How to safeguard your miners 1957: 66
Miami uses slusher and belt - conveyor scheme 1957: 46
The Mine Office: tools and techniques 1958: 29
Mine power: conductors and circuits 1958: 36
Panorama of auxiliary fans 1957: 55
Proper grounding insures safety in the pit (charts) ..... 1954: G 114

Shaft safety through communications 1955: 44
Some unique fan installations 1957: 56
Today's fans meet exacting ventilation needs 1957: 54

Use this table to narrow down your dust collector choice 1957: 100

Silver
Gravity and flotation concentration of cobalt-silver at Cobalt (flowsheet) 1958: 81
Smelting cobalt-silver ores at Deloro (flowsheet) 1958: 89

Sizing, Dewatering & Dust Collecting also see: Agglomerating (flocculating); Pyrolytic Processing (drying); does not cover ventilation or pollution (see Safety)
Dust and fume collecting—misfit installations unnecessary (chart & table) 1956: 140
Facts about filter fabric 1957: 99
How cyclones perform—case histories from the mining industry 1957: 90
How to get the most out of a wet cyclone 1957: 86
Separating solids from liquids 1956: 117
Use this table to narrow down your dust collector choice 1957: 100
Vacuum and pressure filters for concentrate and process water (tables) 1957: 96

Solution Processing also see: Sizing (solid-liquid separation, flocculating); Pyrolytic Processing (molten salt electrolysis)
Calera Mining Co. flowsheet 1957: 120
Chemical metallurgy solves low-grade, complex-ore problems H. L. Talbot 1955: 52
Chemical techniques unlock laterites 1955: 54
Column ion exchange at Bicroft Uranium Mines Ltd. (flowsheet) 1958: 92
Column ion exchange for uranium at Dawn Mining Co. (flowsheet) 1958: 82
Cyanide for gold at Belleterre Quebec (flowsheet) 1958: 80
Electrolytic cadmium at Anaconda Co. (flowsheet) 1958: 84
Electrolytic chromium at Key Metals Corp. (patent) 1958: 84
Estimating reagent cost to recover uranium (table) 1957: 105
How Inco produces electrolytic nickel from nickel matte (flowsheet) 1958: 95
If you are planning uranium extraction, take a look at today's flowsheets W. L. Lennemann (tables) 1956: 122
Nickel Processing Corp. Nicaro plant 1957: 118
Producing electrolytic cobalt at Calera Mining Co. (flowsheet) 1958: 72
Removing magnesia from electrolytic zinc circuit at Bunker Hill Co. (flowsheet) 1958: 88

Resin-in-pulp at Uranium Reduction Co. (flowsheet) 1958: 78
Rise of chemical metallurgy 1957: 118
Sherritt Gordon Mines Ltd. flowsheet 1957: 121
Solvent extraction—liquid-liquid separation 1957: 104

Solvent extraction for uranium at Vitro Uranium Co. (flowsheet) 1958: 87
Solution processing of cobalt at Sherritt Gordon Mines Ltd. (flowsheet) 1958: 71
Solution processing of nickel at Sherritt Gordon Mines Ltd. (flowsheet) 1958: 73
These metals respond to solvent extraction (chart) 1957: 105
Try ion exchange for complex ores (tables) 1956: 133
Uranium extraction flowsheets 1957: 122
Uranium metallurgy highlights (table) 1955: 95
Using acetone to extract uranium (patent) 1958: 74

Where ion exchange fits in hydrometallurgy Mindler & Paulson (chart & tables) 1955: 56

Sulphur
How fluidization can serve the mineral industries T. B. Counselman 1955: 70

Titanium
Gravity-electrical concentration at Metal & Thermit's rutile-ilmenite concentrator (flowsheet) 1958: 77
Pit-to-smelter facilities in Canada ..... 1954: G 140

Transporting & Hoisting, Mine also see: Loading (feeding, muck passes and chutes, dumping); Materials Handling (other than mine)
ASEA friction-drive hoists delivered or under manufacture for mines in the U. S. and Canada (table) 1957: 38
Butte combines gravity and slushing 1957: 48
Cleveland Cliffs Koepe hoist installation 1957: 38
Climax scrapes below unusual undercut 1957: 44
Conveyor design charts ..... 1954: G 74

Conveyors—chart for easy conveyor selection ..... 1954: G 76

Conveyors—a 95% payload ..... 1954: G 70

Earthmoving—bigger units call for better handling ..... 1954: G 34

Electrical aspects of friction vs drum hoists Huseman & Moore 1955: 42
Guides to proper selection of modern underground mine equipment Roger Pierce 1955: 33
Handling rock from face to pocket 1956: 70
How to keep solids flowing in bins and hoppers A. W. Jenike (charts) 1955: 83
How to systematize selection of muck handling equipment 1957: 74
The impact of friction-drive hoisting A. W. Knoerr 1955: 41
Locomotives 1956: 58
Miami uses slusher and belt-conveyor scheme 1957: 46
Modern skips and cages 1956: 100
Muck handling specification tables 1957: 76
New choices for better haulage (chart) ..... 1954: G 58

Panorama of earthmoving equipment (charts & tables) 1956: 39
Rail—large tonnage, long haul ..... 1954: G 62

San Manuel's powerful drum hoisting system 1957: 40
Selecting loading and hauling units 1958: 97
Selecting the right wire rope (table) 1957: 42
Shaft safety through communication 1955: 44
Trends in modern mine hoisting 1957: 38
Trucks—bigger, more flexible ..... 1954: G 66

What to consider when selecting mine cars Frank Pickard 1956: 55
What to expect of modern pumps W. B. Stephenson (charts & tables) 1955: 86
Why Homestake selected the cylindro-conical hoist 1957: 41

Underground Mining also see: Mining; Wells
Block caving has many variations 1957: 44
Butte combines gravity and slushing 1957: 48
Climax scrapes below unusual undercut 1957: 44
From bit to shank, many tools make holes 1956: 85

Guides to proper selection of modern underground mine equipment Roger Pierce 1955: 33
Handling rock from face to pocket 1956: 70
Jumbos speed mine drilling 1956: 78
Mechanical ways to mine medium and soft ground 1956: 84
Miami uses slusher and belt-conveyor scheme 1957: 46
Progress in rock drill design 1956: 81
Shaft mucking machines can fit most conditions 1957: 80
What to use for ground support 1957: 50

Uranium
Column ion exchange at Bicroft Uranium Mines Ltd. (flowsheet) 1958: 29
Column ion exchange for uranium at Dawn Mining Co. (flowsheet) 1958: 82
Estimating reagent cost to recover uranium (table) 1957: 105
If you're planning uranium extraction, take a look at today's flowsheets W. L. Lennemann (tables) 1956: 122
Metallurgical types of uranium ore (table) 1955: 94
Resin-in-pulp at Uranium Reduction Co. (flowsheet) 1958: 78
Solvent extraction for uranium at Vitro Uranium Co. (flowsheet) 1958: 87
Uranium extraction flowsheets 1957: 122
Uranium metallurgy highlights (table) 1955: 95
Using acetone to extract uranium (patent) 1958: 74

Water Control, Mine also see: Safety (pollution control)
Modern pumps, their design, applications and selection (table) 1957: 63
Pump power requirements—computation simplified by graph ..... 1954: G 132

Quick guide to the world of pumps 1957: 62
What to expect of modern pumps W. B. Stephenson (charts & tables) 1955: 86

Zinc
Cerro de Pasco Driller's Manual defines exploration procedures H. A. Kursell 1955: 19
Flotation of oxidized lead-zinc at Gorno (flowsheet) 1958: 96
How fluidization can serve the mineral industries T. B. Counselman 1955: 70
Removing magnesia from electrolytic zinc circuit at Bunker Hill Co. (flowsheet) 1958: 88
Shaft safety through communications 1955: 44

2. Manufacturers' Index

A

Abbott, Charles & Associates, 29 West 7th St., New York 23, N. Y.
Abbé Engineering Co. 50 Church St. New York 7, N. Y.
Abrams Aerial Survey Corp.. 606 Shiawassee St., Lansing, Mich.
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Adamas Carbide Co., 121 Market St., Kenilworth, N. J.
Advance Car Mover Co., Inc., Box 536, Appleton, Wis.
AERO SERVICE CORP., 210 East Courtland St., Philadelphia 20, Pa. Page 140.
Aero Service Corp. (Mid-Continent) 1401 South Detroit St., Tulsa, Okla.
Aero Service Corp. (Western) 35 Richards St., Salt Lake City 10, Utah.
Aero Service Corp. de Venezuela, Apartado 3985, Caracas, Venezuela.
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Ahlberg Bearing Co., 3025 W. 47th St., Chicago 32, Ill.
AINSWORTH & SONS, WILLIAM, 2151 Lawrence St., Denver 2, Colo. Page 168.
Air Reduction Sales Co., Div., Air Reduction Co., Inc., 150 East 42nd St., New York, N. Y.
Ajax Flexible Coupling Co., Westfield, N. Y.
Albany Felt Co., Albany 1, N. Y.
Alco Products, Inc., Schenectady 5, N. Y.
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Alloy Steel Casting Co., 204 County Line Rd., Southampton, Pa.
All-State Welding Alloys Co. Inc., 249-55 Ferris Ave., White Plains, N. Y.
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American Air Surveys, Inc., 907 Penn Ave., Pittsburgh 22, Pa.
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American Brass Co., Waterbury 20, Conn.
AMERICAN BRATTICE CLOTH CORP., Warsaw, Ind. Page 194.
American Bridge Div., U. S. Steel Corp. 204 Frick Bldg., Pittsburgh 30, Pa.
American Car & Foundry Div., ACF Industries, Inc., 30 Church St., New York 7, N. Y.
American Chain & Cable Co., Inc., Bridgeport 2, Conn.
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American Crucible Products Co., 1305 Oberlin Ave., Lorain, Ohio.
AMERICAN CYANAMID CO. Explosives Dept., 30 Rockefeller Plaza, New York 20, N. Y. Opposite Page 116
AMERICAN CYANAMID CO., Mining Chemicals Dept., 30 Rockefeller Plaza, New York 20, N. Y.
American Emery Wheel Works, Richmond Square, Providence 1, R. I.
American Flexible Coupling Div., Zurn Industries, Inc., Pittsburgh Ave., Erie, Pa.
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American Hoist & Derrick Co., 63 S. Robert St., St. Paul, Minn.
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American-Marsh Pumps Inc., 60 Capital Ave., Battle Creek, Mich.
American Metal Co., 61 Broadway, New York, N. Y.
AMERICAN MINE DOOR CO., 2039 Dueber Ave., S. W. Canton 6, Ohio. Page 167.
American Oil Co., 555 Fifth Ave., New York 17, N. Y.
American Optical Co., Safety Products Div., 14 Mechanic St., Southbridge, Mass.
American Paulin System 1524 South Flower St., Los Angeles 15, Calif.
Pipe Linings Div., American Pipe & Construction Co., 2414 E. 223 St., Wilmington, Calif.
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American Pulverizer Co., 1275 Macklin Ave., St. Louis 10, Mo.
American Rectifier Corp., 95 Lafayette St., New York, N. Y.
American Rubber Mfg. Co., 1145 Park Ave., Oakland 8, Calif.
American Sand-Banum Co., Inc., Meadow Brook National Bank Bldg., Freeport, N. Y.
AMERICAN SMELTING & REFINING CO., 120 Broadway, New York 14, N. Y. Page 153.
AMERICAN SMELTING & REFINING CO., Federated Metals Div., 120 Broadway, New York 5, N. Y.
American Spectrographic Laboratories, Inc., 557 Minna St., San Francisco, Calif.
American Steel Foundries, Prudential Plaza, Chicago 1, Ill.
American Steel & Wire Div., U. S. Steel Crop., Rockefeller Bldg., Cleveland, Ohio.
American Tractor Equipment Corp., 9131 San Leandro Blvd., Oakland 3, Calif.
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Ampco Metal, Inc., 1739 South 38th St., Milwaukee 46, Wis.
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Analytical Measurements, Inc., 585 Main St., Chatham, N. J.
Anchor Plastics Co., Inc., 36-36 38th St., Long Island City 6, N. Y.
Anderson Mfg. Co., Albert & J. M. 289 A St., Boston 10, Mass.
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Arrow Hart & Hegeman Electric Co., 103 Hawthorne St., Hartford 6, Conn.
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Arrowhead Products Div., Federal-Mogul-Bower, Bearings Inc., 2300 Curry St., Long Beach 5. Calif.
Arrowhead Steel Buildings, Inc., 1122 W. Railroad St., Duluth 2, Minn.
Asbestos Mfg. Co., Huntington, Ind.
ASEA ELECTRIC, INC., 500 Fifth Ave., New York 36, N. Y. Page 124.
Assembly Products, Inc., Wilson Mills Rd., Chesterland 70, Ohio.
ASSOCIATED METALS & MINERALS CORP., 75 West St., New York 6, N. Y. Page 188.
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Athey Products Corp., 5631 West 65th St., Chicago 38, Ill.
Atlantic Refining Co., 260 S. Broad St., Philadelphia, Pa.
Atlantic Tank Corp., 1207 Tonnelle Ave., North Bergen, N. J.
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Atlas Chain & Mfg. Co., P. O. Box 708, West Pittston, Pa.
Atlas Conveyor Co., Clintonville, Wis.
Atlas Copco Eastern, Inc., 151 Linwood Ave., Paterson 25, N. J.
Atlas Copco Pacific, Inc., 930 Brittan Ave., San Carlos, Calif.
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Atlas Steels, Ltd., Welland, Ontario, Canada.
AUSTIN-WESTERN CONSTRUCTION EQUIPMENT DIV., BALDWIN-LIMA-HAMILTON CORP., Aurora, Ill. Page 180.
Auto-Lite Battery Corp., Toledo 1, Ohio
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Automatic Electric Co., Northlake, Ill.
Automatic Switch Co., Hanover Rd., Florham Park, N. J.

B

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Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.
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BOYLES BROS. DRILLING CO., LTD., 1275-1291 Parker St., (Vancouver) Vancouver 6, Canada Page 131.
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Buffalo Forge Co., 490 Broadway, Buffalo 5, N.Y.
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Bush Engineering & Mfg. Co., No. 5 Lester Court, Salt Lake City 1, Utah.
Butler Bin Co., 993 Blackstone Ave., Waukesha, Wis.
Butler Manufacturing Co., 7400 East 13th St., Kansas City, Mo.
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California Testing Laboratories, Inc., 619 E. Washington Blvd., Los Angeles 15, Calif.
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Canadian Locomotive Co., Ltd., Kingston, Ontario, Canada.
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Carbon Engineering Corp., P. O. Box 236, Slinger, Wis.
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Carnille Laboratories, Inc., R. P. 117 Liberty St., New York 6, N. Y.
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Century Electric Co., 1806 Pine St., St. Louis 3, Mo.
Cessna Aircraft Co., 5800 Franklin Rd., Wichita, Kan.
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Chain Belt Co., Shafer Bearing Div., 801 Burlington, Downers Grove, Ill.
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Charcoal Corp. of America, 726 Fairmont Ave., Fairmaont, W. Va.
Charlton Laboratories, 2340 S. W. Jefferson St., Portland 7, Ore.
Chart-Pak, Inc., 100 Lincoln Ave., Stamford, Conn.
Chase Bag Co., 155 East 44th St., New York 17, N.Y.
Chase Brass & Copper Co., 236 Grand St., Waterbury 91, Conn.
Chatillon & Sons, John, 85 Cliff St., New York 38, N. Y.
Chattanooga Boiler & Tank Co., 1036 E. Main St., Chattanooga 1, Tenn.
CHEATHAM ELECTRIC SWITCHING DEVICE CO., 4780 Crittenden Drive, Louisville 9, Ky. Page 200
Chelsea Fan & Blower Co., 639 South Ave., Plainfield, N. J.
Chemalco Inc., 2265 E. Foothill Blvd., Pasadena, Calif.
Chemical Construction Corp., 525 West 43rd St., New York, N. Y.
Chemical & Power Products, Inc., 11 Broadway, New York 4, N. Y.
Chemical Process Co., P. O. Box 829, Redwood City, Calif.
Chesapeake & Ohio Railway, World Commerce Dept., Newport News, Va.
Chester Cable Corp., 521 Fifth Ave., Chester, N. Y.
Chester Hoist Div., National Screw Mfg. Co., Lisbon, Ohio.
Chevrolet Motors Div., General Motors Corp., Detroit 2, Mich.
Chicago Belting Div., Chicago-Allis Mfg. Corp., 113 N. Green St., Chicago 7, Ill.
Chicago Bridge & Iron Co., 332 S. Michigan Ave., Chicago 4, Ill.
Chicago Expansion Bolt Co., 1338 W. Concord Pl., Chicago 22, Ill.
Chicago Eye Shield Co., 2727 W. Roscoe St., Chicago 18, Ill.
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Chicago Pneumatic Tool Co., 6 East 44th St., New York 17, N. Y.
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Chiksan Co., 330 North Pomona Ave., Brea, Calif.
Chisholm-Moore Hoist Div., Columbus McKinnon Chain Corp., 5045 Fremont Ave., Tonawanda, N. Y.
CHRISTENSEN DIAMOND PRODUCTS CO., 1937 South 2nd West St., Salt Lake City 10, Utah Pages 12-13.
Christian Engineers, J. D., 480 Potrero Ave., San Francisco 10, Calif.
Chrysler Corp., Dodge Truck Div., 7900 Joseph Campau Ave., Detroit, Mich.
Cincinnati Electrical Tool Co., 304 Mt. Hope Ave., Cincinnati 4, Ohio.
Cincinnati Mine Mach'y Co., 2980 Spring Grove Ave., Cincinnnati 25, Ohio.
Cincinnati Rubber Mfg. Co., Div., Thor Power Tool Co., Cincinnati 12, Ohio.
Circle F Mfg. Co., 720 Monmouth St., Trenton 4, N.J.
Circle Wire & Cable Corp., 5500 Maspeth Ave., Maspeth, N.Y.
Cities Service Oil Co., 54 Wall St., New York 5, N.Y.
Clarage Fan Co., 619 Porter St., Kalamazoo 16, Mich.
Clark Controller Co., 1146 E. 152nd St., Cleveland 10, Ohio.
Clark Equipment Co., Transmission Div., Jackson 1, Mich.
Clark Equipment Co. Construction Machinery Div., Box 599 Pipestone Rd., Benton Harbor, Mich.
Clarkson Co., 564 Market St., San Francisco 4, Calif.
Clayton Manufacturing Co., P.O. Box 550 El Monte, Calif.
Cleveland Crane & Engrg. Co., 5866 E. 289 St., Wickliffe, Ohio.
Cleveland Electric Motor Co., 5213 Chester Ave., Cleveland 3, Ohio.
Cleveland Vibrator Co., 2828 Clinton Ave., Cleveland 13, Ohio.
Cleveland Worm & Gear Co., 3300 East 80th St., Cleveland 4, Ohio.
Climax Engine Mfg. Co., Div. of Waukesha Motor Co., 208 South LaSalle St., Chicago 4, Ill.
Climax Molybdenum Co., 500 Fifth Ave., New York, N.Y.
Cline Truck Co., 3501 Gardner Ave., Kansas City 20, Mo.
Cling-Surface Co., 1032 Niagara St., Buffalo 13, N.Y.
Clipper Belt Lacer Co., 974 Front St., N.W. Grand Rapids 2, Mich.
Clipper Mfg. Co., 2800 Warwick St., Kansas City 8, Mo.
Clyde Iron Works, Inc., 29th Ave., West & Michigan St., Duluth, Minn.
Coal State Construction Co., Morgantown, W. Va.
Coast Mfg. & Supply Co., Box 71 Livermore, Calif.
Coast Metals, Inc., Redneck Ave., Little Ferry, N.J.
COATES STEEL PRODUCTS CO., Greenville, Ill., Page 163.
Cochrane Corp., 17th and Allegheny Philadelphia, Pa.
Coeur d'Alene Hardware & Foundry Co., Wallace, Idaho.
Coffing Hoist Div. Duff-Norton Co., 800 Walter St., Danville, Ill.
Collier Carbon & Chemical Corp., 714 W. Olympic Blvd., Los Angeles 15, Calif.
Collins Co., 100 Front St., Collinsville, Conn.
Collyer Insulated Wire Co., 249 Roosevelt Ave., Pawtucket, R.I.
COLORADO FUEL & IRON CORP., Continental Oil Bldg., Denver 2, Colo. Page 18.
Colorado Iron Works Co. A Subsidiary of Mine & Smelter Supply Co., 3800 Race St., P.O. Box 9041, Denver 16, Colo.
Columbia Electric Mfg. Co., 4519 Hamilton Ave., N.E., Cleveland 14, Ohio.
Columbian Steel Tank Co., 1509 West 12th St., Kansas City 1, Mo.
Columbus Conveyor Co., 869 W. Goodale Blvd., Columbus 8, Ohio.
Columbus Forge & Iron Co., 544 W. First Ave., Columbus 8, Ohio.
Combustion Engineering Inc., 200 Madison Ave., New York 16, N.Y.
Combustion Engineering, Inc., Raymond Div., 1323 N. Branch St., Chicago 22, Ill.
Commercial Shearing & Stamping Co., Dept. EMJ-MG, 1775 Logan Ave., Youngstown, Ohio.
Commercial Solvent Corp., 260 Madison Ave., New York 16, N.Y.
Commercial Testing & Engrg. Co., 228 North LaSalle St., Room 924 Chicago 1, Ill.
Compton, Inc., P.O. Box 1946, Clarksburg, W. Va.
Conco Engineering Works, Mendota, Ill.
Concordia Electric Co., 1521 Saw Mill Run Blvd., Pittsburgh 10, Pa.
Condenser Service & Engineering Co., 150 Observer Highway, Hoboken, N.J.
Cone-Drive Gears Div. Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.
Conley Frog & Switch Co., Bodley Ave., P.O. Box 3188, Memphis 9, Tenn.
CONNELLSVILLE MFG. & MINE SUPPLY CO., Connellsville, Pa. Page 183.
Conrader Co., Inc., R. 236 W. 17th St., Erie, Pa.
Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.
Consolidated Packaging Machinery Corp., 1400 West Ave., Buffalo 13, N.Y.
Construction Machy. Co., Box 120, Waterloo, Iowa.
Continental Copper & Steel Ind. Inc., Wooldridge Div. Sunnyvale, Calif.
Continental-Diamond Fibre Corp., A Subsidiary of Budd Co., Newark, Del.
Continental Electric Co., Inc., 325 Ferry St., Newark 5, N.J.
Continental Gin Co., Industrial Div. P.O. Box 2614, Birmingham 2, Ala.
Continental Mineral Processing Co., First National Bank Bldg., Cincinnati 2, Ohio.
Continental Motors Co., Muskegon, Mich.
Continental Ore Corp., 500 5th Ave., New York 36, N.Y.
Continental Rubber Works, 1939 Liberty St., Erie, Pa.
Control Corp., 718 Central Ave., Minneapolis 14, Minn.
Convair, Inc., Box 9671, Pittsburgh 26, Pa.
Conveycr Systems, Inc., 325 S. California Ave., Chicago, Ill.
Cooper-Bessemer Corp., Mt. Vernon, Ohio.
Coors Porcelain Co., 600 Ninth St., Golden, Colo.
Coover Railroad Track Brace Co., P.O. Box 254, Dayton 1, Ohio.
Copperweld Steel Co., 9th St., & Allegheny Ave., Glassport, Pa.
COPPUS ENGINEERING CO., 344 Park Ave., Worcester 10, Mass. Page 15.
Corhart Refractories Co., 16th & Lee Sts., Louisville 10, Ky.
Cormac Photocopy Corp., 80 Fifth Ave., New York 11, N.Y.

Corning Glass Works, Corning, N.Y.
Coulter Industrial Sales Co., P.O. Box 22, Elmhurst, Illinois.
Crane Co., 836 South Michigan Ave., Chicago 5, Ill.
Crane Puller Co., Waltham 54, Mass.
Crescent Belt Fastener Co., Inc. 480 Lexington Ave., New York, N.Y.
Crescent Insulated Wire & Cable Co., Olden & Taylor Aves., Trenton 5, N.J.
Crosby Valve & Gage Co., 43 Kendrick St., Wrentham, Mass.
Crouse Hinds Co., Wolf & Seventh North Sts., Syracuse 1, N.Y.
CRUCIBLE STEEL CO. OF AMERICA, Oliver Bldg., Mellon Square, Pittsburgh 22, Pa. Page 181.
Cullman Wheel Co., 1344 W. Altgeld St., Chicago 14, Ill.
Cummins Engine Co., Inc. 1000 Fifth St., Columbus, Ind.
Cummins Engine Co., Inc. Fifth & Union Sts., Columbus, Ind.
Curtis Manufacturing Co. 1905 Kienlen Ave., St. Louis 20, Mo.
Curtiss-Wright Corp., Electronics Div. 631 Central Ave., Carlstadt, N.J.
Custom Assay Office, Box 811, El Paso, Tex.
Cutler-Hammer, Inc., 237 N. 12th St., Milwaukee 1, Wis.

D

Dagley Mfg. Co., 1217 East Sixth St., Joplin, Mo.
Daniels Co., Contractors Inc. 26 North Fifth St., Indiana, Pa.
Daniels, Inc., C. R., Daniels, Md.
Darling Valve & Mfg. Co., Foot of Walnut St., Williamsport, Pa.
Darworth, Inc., Chemical Products Div. Simsbury, Conn.
Davey Compressor Co., Kent, Ohio.
Davidson Co., M. T., 7 Dey St., New York 7, N.Y.
Davis Foundry & Machine Works, Old Furnace Road, Rome, Ga.
Deere Co., John, Moline, Ill.
Del-Con Eastern Corp., 60 Beaver St., New York, N.Y.
Delta-Star Electric Div. H. K. Porter Co., Inc. 2437 Fulton St., Chicago 12, Ill.
Dietz Co., Inc., Henry G., 12-16 Astoria Blvd., Long Island City 2, N.Y.
Demo Tool Corp., 8735 Melrose Ave., Los Angeles, Calif.
DeSousa Co., Inc., J. E. 217 Broadway, New York 7, N.Y.
DeZurik Corp., Sartell, Minn.
Dean Hill Pump Co., 4000 E. 16th St., Indianapolis 7, Ind.
Deason & Nichols, 160 South West Temple St., Salt Lake City 1, Utah.
Deister Machine Co., 1933 East Wayne St., Fort Wayne 4, Ind.
DeLaval Steam Turbine Co., 855 Nottingham Way, Trenton 2, N.J.
DeLong Engineering Corp., 29 Broadway, New York 6, N.Y.
Deltron Electric Products, Inc., Ebensburg, Pa.
Deming Co., 42 Broadway, Salem, Ohio.
DENVER EQUIPMENT CO., P.O. Box 5268, Denver 17, Colo., Page 161.
Denver Fire Clay Co., 2301 Blake St., P.O. Box 5510, Denver, Colo.
Detectron Corp., 5528 Vineland Ave., North Hollywood, Calif.
Detroit Diesel Engine Div. General Motors Corp., 13400 W. Outer Dr., Detroit 28, Mich.
Detroit Hoist & Machine Co., 8224 Morrow St., Detroit 11, Mich.
Dewey & Almy Chemical Co., Div. W. R. Grace & Co., 62 Whittemore Ave., Cambridge, Mass.
Diamond Chain Co., Inc. 452 Kentucky Ave., Indianapolis 7, Ind.
Diamond Drill Carbon Co., 244 Madison Ave., New York 16, N.Y.
DIAMOND DRILL CONTRACTING CO., Station B-Box 4065, South 18 Stone St., Spokane 15, Wash., Page 194.
Diamond Iron Works Div. Goodman Mfg. Co., Halsted St., 48th Pl. Chicago 9, Ill.
Diamond Power Specialty Corp., Lancaster, Ohio.
Diamond Products, Inc. 336 Prospect Ave., Elyria, Ohio.
DIAMOND TOOL RESEARCH CO., INC. 300 Second Ave., New York 10, N.Y. Page 196.
Dick Co., R. & J., Sade St., Passaic, N.J.
Dicke Tool Co., 1201 Warren Ave., Downers Grove, Ill.
Dickinson Laboratories, Inc., 1300 W. Main St., El Paso, Tex.
Diehl Mfg. Co., 1199 Finderne Ave., Somerville, N.J.
DIESEL ENERGY CORP., 82 Beaver St., New York, N.Y., Page 202.
Dill Mfg. Co., 700 East 82nd Street, Cleveland 3, Ohio.
Dings Magnetic Separator Co., 4740 West Electric Ave., Milwaukee 46, Wis.
Dixon Crucible Co., Joseph Monmouth & Wayne St., Jersey City 3, N.J.
Dixon Valve Coupling Co., Philadelphia 22, Pa.
Differential Steel Car Co., Findlay, Ohio.
Dodge Mfg. Corp., South Union St., Mishawaka, Ind.
Dominion Steel & Coal Corp., Ltd. Canada Cement Bldg., Montral, Quebec, Canada.
Dorr-Oliver, Inc., Barry Place, Stamford, Conn.
Dow Chemical Co., T.S.O.B. Midland, Mich.
Dow Corning Corp., Midland, Mich.
Dravo Corp., Neville Island, Pittsburgh 25, Pa.
Dresser-Ideco Co., 975 Michigan Ave., Columbus 8, Ohio.
Dresser Mfg. Div. Dresser Industries, Inc., Bradford, Pa.
Drilling Accessory & Mfg. Co., Inc. 2006 S. Industrial, P.O. Box 5768, Dallas, Tex.
Drott Mfg. Co., 3841 West Wisconsin Ave., Milwaukee 8, Wis.
DUCON CO., INC., 153 East Second St., Mineola, N.Y., Page 197.
Duff Norton Co., 2709 Preble Ave., Pittsburgh 30, Pa.
DuPont de Nemours & Co., Inc., E. I. Wilmington, Del.
DuPont de Nemours & Co., Inc. E. I. Explosives Dept. 2543 Nemours Bldg., Wilmington 98, Del.
DuPont de Nemours & Co., Inc., E. I. Fabrics Div. Fairfield 6, Conn.
Duquesne Mine Supply Co., Pittsburgh 9, Pa.
Durakool, Inc., 1010 N. Main St., Elkhart, Ind.
Duriron Co., Inc., 450 North Findlay St., Dayton 4, Ohio.
Dustex Corp., Box 2520, 1758 Walden Ave., Buffalo 25, N.Y.
Dwight-Lloyd Div., McDowell Co., Inc., 16300 Waterloo Rd., Cleveland 10, Ohio.

E

Eagle Iron Works, P.O. Box 934, Des Moines 4, Iowa.
Eagle-Picher Co., American Bldg., Cincinnati 1, Ohio.
Eastman Kodak Co., Business Photo Methods Div., 343 State Street, Rochester 4, N.Y.
Eastman Mfg. Co., 1440 N. 24th St., Manitowoc, Wis.
Eastman-Pacific Co., 2320 East Eighth St., Los Angeles 21, Calif.
Easton Car & Construction Co., Easton, Pa.
Eaton Mfg. Co., 739 E. 140th St., Cleveland 10, Ohio.
Edison, Inc., T. A. Edison Storage Battery Div., Lakeside Ave., West Orange, N.J.
Edmund Scientific Co., 101 East Gloucester Pike, Barrington, New Jersey.
Edward Valves, Inc., 1200 W. 145th St., East Chicago, Ind.
EIMCO CORP., 634 South Fourth West St., Box 300, Salt Lake City 10, Utah, Pages 184-185.
Eisler Engineering Co., 740 S. 13th St., Newark 3, N.J.
Elastic Stop Nut Corp. of America, 2330 Vauxhall Rd., Union, N.J.
Electric Controller & Mfg. Co. Div Square D Co. 4500 Lee Rd, Cleveland 28, Ohio.
Electric Machinery Mfg. Co., 800 Central Ave., Minneapolis 13, Minn.
Electric Materials Co., North East, Pa.
Electric Specialty Co., 211 South St., Stamford, Conn.
Electric Steel Foundry Co., 2141 North West 25th Ave., Portland 10, Ore.
ELECTRIC STORAGE BATTERY CO., EXIDE INDUSTRIAL DIV. 42 S. 15th St., Philadelphia 2, Pa., Page 164.
Electrical Fittings Corp., 37-50 57 St., Woodside 77, N.Y.
Electro Dynamics Div., General Dynamics Corp., Bayonne, N.J.
ELEKTROKEMISK A. S., 101 Park Ave., New York, N.Y., Page 204.
Electro Lift, Inc., 204 Sargeant Ave., Clifton, N.J.
Electro Products Laboratories, 4501 North Ravenswood Ave., Chicago, Ill.
Electro Refractories & Abrasives Corp., Willets Rd. Buffalo 19, N.Y.
Elgin National Watch Co., 2435 N. Naomi St., Burbank, Calif.
Elkhart Brass Mfg. Co., Inc., 1302 W. Beardsley Ave., Elkhart, Ind.
Elliott Co., 900 North Fourth Ave., Jeannette, Pa.
Ellicott Machine Corp., 1657 Bush St., Baltimore 30, Md.
Elliott Service Co., Inc., 30 North MacQuesten Pkwy., Mt. Vernon, N.Y.
El Paso Testing Laboratories, El Paso, Tex.
Elreco Corp., 2900 Cormany Ave., Cincinnati 25, Ohio.
El-Tronics, Inc., 1360 Sub. Sta. Build., Philadelphia 3, Pa.
Emery Industries, Inc., Crew Tower Cincinnati 2, Ohio.
Empire Steel Castings, Inc., Box 139, Reading, Pa.
Endicott Forging & Mfg. Co., 1901 North St., Endicott, N.Y.
Engelhard, Inc., Charles, 850 Passaic Ave., East Newark, N.J.
Engelhard Industries, Inc., 113 Astor St., Newark, N.J.
Engineered Equipment, Inc., 1001 Linden Ave., Waterloo, Iowa.
Engineers Syndicate, Ltd., 5011 Hollywood Blvd., Hollywood, Calif.
Engler Instriument Co., 250 Culver Ave., Jersey City 5, N.J.
Enley Products, Inc., 1236 Broadway, Brooklyn 21, N.Y.
ENSIGN-BICKFORD CO., Simsbury, Conn. Page 2.
Ensign Electric & Mfg. Co., 914 Adams Ave., Huntington 4, W. Va.
Enterprise Wheel & Car Corp., Bristol, Va.
EQUIPMENT ENGINEERS INC., 41 Sutter St., San Francisco 4, Calif., Page 125.
Equitable Paper Bag Co., Inc., 45-50 Van Dam St., Long Island City 1, N.Y.
Equitable Powder Mfg. Co., East Alton, Ill.
Erie Pump & Engine Works, 144 Glenwood Ave., Medina, N.Y.
Erie Strayer Co., Erie, Pa.
Eriez Mfg. Co., 263 Magnet Dr., Erie, Pa.
Essex Wire Corp., Paranite Wire & Cable Div. 1601 Wall St., Fort Wayne 6, Ind.
Essick Manufacturing Co., 1950 Santa Fe Ave., Los Angeles 21, Calif.
Esso Standard Oil Co., National & Comm. Sales Div. 15 West 51st St., New York 19, N.Y.
Esterline-Angus Co., Inc., P.O. Box 596, Indianapolis 6, Ind.
Ettco Wire & Cable Corp., 75 Onderdonk Ave., Brooklyn 37, N.Y.
Euclid Div. General Motors Corp., 1361 Chardon Rd., Cleveland 17, Ohio.
Eutectic Welding Alloys Corp., 40-40 172nd St., Flushing 58, N.Y.
Evanite Plastic Co., Div. Evans Pipe Co., 23 Newport Ave., Uhrichsville, Ohio.
Everlasting Valve Co., 49 Fisk St., Jersey City 5, N.J.
Exolon Co., East Niagara St., Tonawanda, N.Y.
Exploration Methods, Inc., P.O. Box 100, Ishpeming, Mich.
Extremultus, Inc., 405 Lexington Ave., New York, N.Y.

F

F. A. B. Mfg. Co., 1249—67th St., Oakland 8, Calif.
Fafnir Bearing Co., 37 Booth St. New Britain, Conn.
Fahrenwald Co., A. W. E. 3500 Riverside, Spokane, Wash.
Failing Co., George E. Enid, Okla.
Fairbanks Co., 393 Lafayette St., New York 3, N.Y.
Fairbanks, Morse & Co., 600 South Michigan Ave., Chicago 5, Ill.
Fairchild Aerial Surveys, Inc. 224 E. 11th St., Los Angeles, Calif.
Falcon Alarm Co., Inc., 243 Broad St., Summit, N.J.
FALK CORP., 3049 West Canal St., Milwaukee 1, Wis., Page 119.
Farbwerke Hoechst, A. G., Frankfurt (M)—Hoechst, Germany.
Farrel-Birmingham Co., Inc., Ansonia, Conn.
Farrell-Cheek Steel Co., Sandusky, Ohio.
Farris Flexible Valve Corp., 463 Commercial Ave., Palisades Park, N.J.
Farval Corp., 3249 East 80th St., Cleveland 4, Ohio.
FATE-ROOT-HEATH CO., Bell, High & Pine Sts., Plymouth, Ohio, Page 209.
Fawick Airflex Co., Inc. 9919 Clinton Ave., Cleveland 11, Ohio.
Federal Bearings Co., Inc., Poughkeepsie, N.Y.
Federal-Mogul Service Div. Federal-Mogul-Bower Bearings, Inc. 11031 Shoemaker, Detroit 13, Mich.
Federal Motor Truck Div. Napco Industries Inc., 7th St.—N. Lyndale, Minneapolis 11, Minn.
Federal Pacific Electric Co., Pacific Switchgear Div. 5815 Third St., San Francisco 24, Calif.
Federal Pacific Electric Co., 50 Paris St., Newark 5, N.J.
Federal Sign & Signal Corp., 8763 South State St., Chicago 19, Ill.
Federal Telephone & Radio Div., International Tel. & Tel. Corp., 100 Kingsland Rd., Clifton, N.J.
Felt Products Mfg. Co., 7450 N. McCormick Blvd., Skokie, Ill.
Femco, Inc., Irwin, Pa.
Firestone Tire & Rubber Co., 12 South Main St., Akron 17, Ohio.
Firth Sterling Inc., 3113 Forbes Ave., Pittsburgh 30, Pa.
Fisher Research Laboratory, Inc. 1961 University Ave., Palo Alto, Calif.
Fischer & Porter Co., 415 Warminster Rd., Hatboro, Pa.
Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.
Fiske Bros. Refining Co., Lubriplate Div., 129 Lockwood St. Newark 5, N.J.
Fitz Simons & Connell Dredge & Dock Co., 10 South LaSalle St., Chicago 3, Ill.
Fletcher & Co., J. H., 707 W. 7th St., Huntington, W. Va.
Flexaust Co., 100 Park Ave., New York 17, N.Y.
Flexible Steel Lacing Co., 4607 Lexington St., Chicago 44, Ill.
Flexible Tubing Co., Guilford, Conn.
Flexo Products, Inc., 24864 Detroit Rd., Westlake, Ohio.
Flocker & Co., John, 644 Grant St., Pittsburgh 19, Pa.
Flood City Brass & Elec. Co., Johnstown, Pa.
Fluor Products Co., Hartmann Div. 1200 East Washington Blvd., Whittier, Calif.
Fly Ash Arrestor Corp., P.O. Box 1883 Birmingham 1, Ala.
Foley Bros. Construction Co., Pleasantville, N.Y.
Food Machinery & Chemical Corp., Packing Equipment Div., P.O. Box 552, Riverside, Calif.
Peerless Pump Div., Food Machinery & Chemical Corp., 301 West Ave., 26, Los Angeles 31, Calif.
Food Machinery & Chemical Corp., Westvaco Mineral Products Div., Westvaco Chlor-Alkali Div., 161 E. 42nd St., New York 17, N.Y.
Foote Bros. Gear & Machine Corp., 4545 S. Western Blvd., Chicago 9, Ill.
Ford Motor Co., P.O. Box 658, Dearborn, Mich.
Forker Corp., 2044 Random Rd., Cleveland 6, Ohio.
Formica Corp., Subsidiary of Cyanamid 4614 Spring Grove Ave., Cincinnati 32, Ohio.
Foster Co., L. B. P. O. Box 1647 Pittsburgh 30, Pa.
Foster Wheeler Corp., 666 Fifth Ave., New York 19, N.Y.
Four Wheel Drive Auto Co., Clintonville, Wis.
Foxboro Co., Foxboro, Mass.
Frank, M. K., 480 Lexington Ave., New York 17, N.Y.
Franklin Plastics Co., 315 Grant St., Franklin, Pa.
Frantz Co., Inc. S. G. Brunswick Pike & Kline Ave., P.O. Box 1138, Trenton 6, N.J.
Frazier Davis Construction Co. 1319 Macklind Ave., St. Louis, Mo.
Frederick Post Co., 3650 N. Avondale Ave., Chicago 18, Illinois.
Frog Switch & Mfg. Co., Carlisle, Pa.
Frontier Mfg. Co., P.O. Box 13266, 10600 Harry Hines Blvd., Dallas, Texas.
Fruehauf Trailer Co., 10940 Harper Ave., Detroit 32, Mich.
Fuller Co., Catasauqua, Pa.
Fuller Manufacturing Co., 1410 North Burdick St., Kalamazoo, Mich.
Fuel Process Co., D at 10th St., South Charleston, W. Va.
Fulton Bag & Products Co., 1400 Annunciation St., New Orleans 13, La.
Fyr-Fyter Co., 221 Crane St., Dayton 1, Ohio.

G

Gallagher Co., P.O. Box 209, Salt Lake City 10, Utah.
Gallion Allsteel Body Co., Gallion, Ohio.
Gallion Iron Works, Gallion, Ohio.
Galland Henning Mfg. Co., Nopak Div. 2753 South 31st St., Milwaukee 46, Wis.
G. & W. Electric Specialty Co., 3500 W. 127th St., Blue Island, Ill.
Gar Wood Industries, Inc., Wayne, Mich.
GARDNER-DENVER CO., Quincy, Ill., Pages 148-149.
Garlock Packing Co., 402 East Main St., Palmyra, N.Y.
Garrett Corp., 9851 Sepulveda Blvd.,

Los Angeles 45, Calif.
Gates Engrg. Co., 100 South West St., Wilmington 99, Del.
Gates Rubber Co., 999 South Broadway, Denver 17, Colo.
Gatke Corp., 228 N. LaSalle St., Chicago 1, Ill.
General American Transportation Corp., 135 South LaSalle St., Chicago 90, Ill.
General American Transportation Corp., Louisville Dryer Div., 139 South Fourth St., Louisville, Ky.
General Cable Corp., 420 Lexington Ave., New York 17, N.Y.
General Electric Co., Apparatus Sales Div. Schenectady 5, N.Y.
General Electric Co., Construction Materials Div. 1285 Boston Ave., Bridgeport 2, Conn.
General Electric Co., Gear Motor & Transmission Components Dept., 845 E. 25th St., Paterson, N.J.
General Electric Co., Ind. Haulage Div.—Loco. & Car Equip. Divs., 2901 East Lake Rd., Erie, Pa.
General Equipment & Mfg. Co., 120 S. Campbell St., Louisville, Ky.
General Mills, Inc., Fourth St. & Second Ave., S. Minneapolis, Minn.
General Motors Corp., Allison Div. 4700 West Tenth St., Indianapolis 6, Ind.
General Motors Corp., Electro-Motive Div. La Grange, Ill.
General Motors Corp., Hyatt Bearings Div. 427 Middlesex St., Harrison, N.J.
General Nuclear Corp., 550 Fifth Ave., New York 38, N.Y.
General Refractories, Co., 1520 Locust St., Philadelphia, Pa.
General Splice Corp., 18 Marshall St., South Norwalk, Conn.
General Steel Warehouse Co., Inc. Gemsco Tool Div. 1830 North Kostner Ave., Chicago 39, Ill.
General Switch Co., Div. Norbute Corp., 45 Roebling St., Brooklyn 11, N.Y.
General Tire & Rubber Co., 1708 Englewood Ave., Akron, Ohio.
Geochemical Prospecting Laboratory 460 Newton Street, Denver 4, Colorado.
Geo-Optic Co., Inc. 149 Church St., New York 7, N.Y.
Geophysical Instrument & Supply Co., 1616 Broadway, Denver 2, Colorado.
Geophysical Specialties Co., 4206 Longfellow St., Minneapolis, Minn.
Georgia Iron Works Co., 605 12th St., Augusta, Ga.
Geo-Resource Corp., 525 Hutton Bldg., Spokane, Wash.
Gerber Scientific Instrument Co., 162 State St., Hartford 1, Conn.
Gering Products, Inc., North Seventh St., Kenilworth, N.J.
Getman Brothers, U.S. 31, South Haven, Mich.
Giant Grip Mfg. Co., 29 Osceola St., Oshkosh, Wis.
Gibraltar Equipment & Mfg. Co., P.O. Box 304, Alton, Ill.
Gilson Screen Co., 110 Center St., Mallinta, Ohio.
Gladding, McBean & Co., 2901 Los Feliz Blvd., Los Angeles 39, Calif.
GODOY & CO., INC., E. A. 25 Broadway, New York 4, N.Y., Page 160.
Goldak Co., Inc. 1544 West Glenoaks Blvd., Glendale 1, Calif.
Golden-Anderson Valve Specialty Co., 1232 Ridge Ave., Pittsburgh 33, Pa.
Goodall Brothers, 46 S. Main St., Helena, Mont.
Goodman Mfg. Co., 48th Place & Halstead, Chicago, Ill.
GOODRICH AVIATION PRODUCTS, B.F. DIVISION, B.F. GOODRICH CO., Troy, Ohio. Page 120.
GOODRICH CO., B. F. TRUCK & BUS TIRE DEPT. 500 South Main St., Akron 18, Ohio.
GOODRICH INDUSTRIAL PRODUCTS CO., B. F. 476 Main St., Akron 18, Ohio.
Goodall Rubber Co., Whitehead Rd., Trenton, N.J.
Goodyear Tire & Rubber Co., 1144 East Market St., Akron 16, Ohio.
Goodyear Tire & Rubber Co., Industrial Products, 1144 East Market St., Akron, Ohio.
Gorman-Rupp Co., Mansfield, Ohio.
GOULD CO., GORDON I. 58 Sutter St., San Francisco 4, Calif., Page 210.
Gould-National Batteries, Inc., Trenton 7, N.J.
Gowds Pumps, Inc., Seneca Falls, N.Y.
Goyne Pump Co., Ashland, Pa.
Grace & Co., W. R. Hanover Square, New York, N.Y.
Gramm Trailer Corp., 425 E. O'Connor St., Lima, Ohio.
Graton & Knight Co., Inc. 356 Franklin St., Worcester 4, Mass.
Graver Tank & Mfg. Co., Inc. East Chicago, Ind.
Graver Water Conditioning Co., 216 W. 14 St., New York 11, N.Y.
Gray & Co., Inc. 60-11th Ave., N.E. Minneapolis 13, Minn.
Gray Instrument Co., 200 E. Church Lane, Philadelphia 44, Pa.
Gratuor Elec. Co., Inc. 420 Lexington Ave., New York 17, N.Y.
Green Fire Brick Co., A. P. Mexico, Mo.
Greene, Tweed & Co., North Wales, Pa.
Greensburg Machine Co., Greensburg, Pa.
Gregg Co., Ltd., 214 Main St., Hackensack, N.J.
Grinnell Co., Inc. 260 West Exchange St., Providence 1, R.I.
Gripohoist, Inc., 424 Bryant St., San Francisco 9, Calif.
Gruendler Crusher & Pulverizer Co., 2915 North Market St., St. Louis 6, Mo.
Gulf Oil Corp., Dept. DM Gulf Bldg., P.O. Box 1166, Pittsburgh 30, Pa.
Gundlach Machine Co., T. J. Div. of JMJ Industries, Inc., 226 Centreville Ave., Belleville, Ill.
Gurley, W. & L. E., 514 Fulton St., Troy, N.Y.
Gustin-Bacon Mfg. Co., 210 West Tenth St., Kansas City, Mo.
Guyan Machy. Co., 755 Stratton, Logan, W. Va.
Gwilliam Co., 360 Furman St., Brooklyn 1, N.Y.

H

H-B Instrument Co., Inc. American & Bristol Sts., Philadelphia 40, Pa.
H. & L. Tooth Co., 1540 South Greenwood Ave., Montebello, Calif.
Hack Engineering Co., 124 Wazee Market, Denver, Colo.
Haeuler Metal & Ore Corp., 11 W. 42 St., New York, N.Y.
Hagan Chemicals & Controls, Inc., Divisions: Calgon Co., Hall Laboratories, Hagan Bldg., Pittsburgh 30, Pa.
Hales Co., W. M. Box 65, 700 Commerce St., Danville, Ill.
Hall & Sons, Ames H., 5500 N. Water St., Philadelphia 20, Pa.
Hallett Diesel Engine Div. American MARC, Inc. 1601 W. Florence Ave., Inglewood, Calif.
Hamer Valves, Inc. P.O. Box 1851, Long Beach 1, Calif.
Hamilton Rubber Mfg. Corp., Meade St., Trenton, N.J.
HAMMOND CO., J. V. Spangler, Pa., Page 210.
Handy & Harman, 82 Fulton St., New York 38, N.Y.
Hanks, Inc., Abbot A., 624 Sacramento St., San Francisco 11, Calif.
Hanman Conveyers, Inc., 630 Gibson St., Kalamazoo 6, Mich.
HARBISON-WALKER REFRACTORIES CO., 307 Fifth Ave., Pittsburgh 22, Pa., Pages 158-159.
Hard-N-Tuff Corp., Box 275, Huntington, N.Y.
HARDINGE CO., INC. 240 Arch St., York, Pa., Pages 146-147.
HARNISCHFEGER CORP., 4400 W. National Ave., Milwauke 46, Wis., Page 121.
HARNISCHFEGER CORP. P & H DIESEL DIV. Crystal Lake, Ill.
Harper Electric Furnace Corp., 110 Pearl St., Buffalo 2, N.Y.
Harrington Co., Gravers Rd., at the Turnpike, Plymouth Meeting, Pa.
Hart Mfg. Co., 119 Bartholomew Ave., Hartford, Conn.
Hartman Div. Fluor Products Co., 1200 E. Washington Blvd., Whittier, Calif.
Hartzell Propeller Fan Co., P.O. Box 909, Piqua, Ohio.
Hauck Manufacturing Co., 126 Tenth St., Brooklyn 15, N.Y.
Hauser-Stander Tank Co., 4820 Spring Grove Ave., Cincinnati 32, Ohio.
Havlick, J. L., 112 S. Cedar St., Spokane, Wash.
Hawley & Hawley, Assayers & Chemists, Inc. Box 1060, Douglas, Ariz.
HAWTHORNE, INC., HERB J. Box 7366 Houston 8, Tex., Page 205.
Hayes Steel Products, Ltd., Merritton, Ontario, Canada.
Haynes Stellite Co. Div. Union Carbide Corp., Kokomo, Ind.
Hayward Co., 50 Church St., New York, N.Y.
Hazemag USA, Inc. 122 E. 42 St., New York 17, N.Y.
Heil Co., 3000 W. Montana, Milwaukee, Wis.
Heineken, Inc. W. P., 50 Broad St., New York, N.Y.
Heinsmann Electric Co., 98 Plum St., Trenton 2, N.J.
Heintz Mfg. Co., 13110 Enterprise Ave., Cleveland 11, Ohio.
Helmick Foundry-Machine Co., PO Box 71, Fairmont, W.Va.
Helwig Co., 2544 N. 30th St., Milwaukee 10, Wis.
Hendrick Mfg. Co., Carbondale, Pa.
Hendrickson Mfg. Co., 8001 W. 47th St., Lyons, Ill.
Hendrix Mfg. Co., Mansfield, La.
HERCULES MOTORS CO., 101-11 St., S.E. Canton, Ohio, Page 213.
HERCULES POWDER CO., 933 King St., Wilmington, Del., Page 154.
Hercules Steel Products Corp., Galion, Ohio.
Hertner Electric Co., 12690 Elmwood Ave., N.W. Cleveland 11, Ohio.
Hevi-Duty Electric Co., 2040 W. Wisconsin Ave., Milwaukee 1, Wis.
HEWITT-ROBINS, INC., 666 Glenbrook Rd., Stamford, Conn., Pages 136-137.
Heyden Newport Chemical Corp., 342 Madison Ave., New York, New York.
Heyl & Patterson, Inc., 55 Fort Pitt Blvd., Pittsburgh 22, Pa.
Hill & Jude, Assayers, 800 Pearl St., Boulder, Colo.
Hiller Helicopters, 1350 Willow Rd., Palo Alto, Calif.
Hills-McCanna Co., 4644 W. Touhy Ave., Chicago 30, Ill.
Hirsch Bros. Machy. Co., P.O. Box 226, El Paso, Tex.
Hisey-Wolf Machine Co., Galvin & Mt. Hope Aves., Cincinnati 4, Ohio.
Hobart Bros. Co., Main & Adams St., Troy 1, Ohio.
Hockensmith Corp., Penn, Pa.
HOFFMAN BROS. DRILLING CO., Tiona St., Ext. Punxsutawney, Pa. Page 208.
Holman Bros.—Canada Ltd., 97 Kent Ave., Kitchener, Ontario, Canada.
Holmes & Bros., Inc. Robert, 570 Junction Ave., Danville, Ill.
Homer Mfg. Co., Lima, Ohio.
Homelite Div., Textron Inc., 75 Riverdale Ave., Port Chester, N.Y.
Hose-McCann Telephone Co., 25th St., & Third Ave., Brooklyn 32, N.Y.
Hossfeld Mfg. Co., Winona, Minn.
Hough Co., The Frank G., 726 Seventh St., Libertyville, Ill.
Houghton & Co., E. F., 303 W. Lehigh Ave., Philadelphia 33, Pa.
House & Sons, Inc., Chas. W., Unionville, Conn.
Houston Technical Laboratories, 2424 Brenard Houston 6, Texas.
Houston Tool Co., Inc. Santa Susana, Calif.
Howe Scale Co., Inc. Rutland, Vt.
Howell Electric Motors Co., Howell, Mich.
Hoyland Steel Co., Inc. 5104 Chrysler Bldg., 405 Lexington Ave., New York, N.Y.
Hoyt Wire Cloth Co., Box 22, Lancaster, Pa.
Huber-Warco Co., Marion, Ohio.
Hughes Tool Co., 300 Hughes, Houston, Tex.
Hulburt Oil & Grease Co., Trenton & Castor Aves., Philadelphia 34, Pa.
HUMPHREYS INVESTMENT CO., ENGINEERING DIV. 915 First National Bank Bldg., Denver 2, Colo., Page 192.
Hunt & Son, Inc., C. B., Salem, Ohio.
Hunting Tech. & Exploration Serv. Ltd., 1450 O'Conner Dr., Toronto 16, Canada.
Hutchinson Bag Corp., Hutchinson, Kans.
Hycon Aerial Surveys, Inc., 1020 S. Arroyo Pkwy., Pasadena, Calif.
Hypro Engineering, Inc., 700 39 Ave., N.E. Minneapolis 21, Minn.
Hyster Co., 2965 N.E. Clackamas St., Box 4318, Portland 8, Ore.

I

I-T-E Circuit Breaker Co., 19th & Hamilton Sts., Philadelphia 30, Pa.
Ideal Electric & Mfg. Co., Mansfield, Ohio.
Ideal Industries, Inc., 1020 Park Ave., Sycamore, Ill.
Ilg Electric Ventilating Co., 2850 N. Pulaski Rd., Chicago 41, Ill.
Illinois Iron & Bolt Co., 1932 Thomas St., Carpentersville, Ill.
Illinois Powder Mfg. Co., 506 Olive St., St. Louis 1, Mo.
Illinois Testing Laboratories, Inc., 420 N. La Salle St., Chicago 10, Ill.
Imperial-Cantrell Mfg. Co., PO Box 538, Jellico, Tenn.
Imperial Electric Co., 63 Ira Ave., Akron 9, Ohio.
Imperial Oil & Grease, 6505 Wilshire Blvd., Los Angeles, Calif.
Indiana Foundry Co., Indiana, Pa.
Industrial Air Products Co., 3200 N. W. Yeon Ave., Portland 10, Ore.
Industrial Brownhoist Corp., 135 Washington Ave., Bay City, Mich.
Industrial Engrg. & Construction Co., First National Bank Bldg., Fairmont, W. Va.
Industrial Gloves Co., 700 Garfield St., Danville, Ill.
Industrial Overlay Metals, Inc., 410 N. Barron St., Eaton, Ohio.
Industrial Nucleonics Corp., 1203 Chesapeake Ave., Columbus, Ohio
INDUSTRIAL PHYSICS & ELECTRONICS CO., 470 South Tenth East St., Salt Lake City 2, Utah, Page 198.
Infico, Inc., 901 S. Campbell Ave., Tucson, Ariz.
INGERSOLL-RAND CO., 11 Broadway, New York 4, N.Y., Page 1.
Inland Steel Co., 38 S. Dearborn St., Chicago 3, Ill.
Inland Steel Products Co., 4101 W. Burnham St., Milwaukee 1, Wis.
Insley Manufacturing Corp., 801 N. Olney St., Indianapolis 6, Ind.
International Electronics Corp., 1551 Franklin Ave., Mineola, New York.
INTERNATIONAL BARTERING CO., 52 Broadway, New York, N.Y., Page 196.
International Harvester Co., Motor Truck Div. 180 North Michigan Ave., Chicago 1, Ill.
International Harvester Export Co., 180 No. Michigan Ave., Chicago 1, Ill.
INTERNATIONAL MINERALS & METALS CORP., 11 Broadway, New York 4, N.Y., Page 210.
International Nickel Co., 67 Wall St., New York 5, N.Y.
International Research & Development Corp., 797 Thomas Lane, Columbus 16, Ohio.
International Salt Co., Scranton 2, Pa.
International Shoe Co., 1509 Washington Ave., St. Louis 3, Mo.
Interstate Drop Forge Co., 4051 27th St., Milwaukee 16, Wis.
Ionics, Inc., 152 Sixth St., Cambridge 42, Mass.
IOWA MFG. CO., 916-16th St., N.E. Cedar Rapids, Iowa, Page 129.
Ironton Engine Co., Farmingdale, N.J.
Ironton Fire Brick Co., Ironton, Ohio.
Irwin Foundry & Mine Car Co., Box 311, Irwin, Pa.
Irvington Div. Minnesota Mining & Mfg. Co., 6 Argyle Terrace, Irvington 11, N.J.
Irving Subway Grating Co. Inc., 50-99 27th St., Long Island City 1, N.Y.
ISBELL CONSTRUCTION CO., P.O. Box 2351, Reno, Nev. Page 190.
Isotope Products, Inc. Instrument Div., 1717 Elmwood Pierce Arrow, Buffalo, N.Y.

J

Jacsco Pumps, 2031 N. Lincoln St., Burbank, Calif.
Jacuzzi Bros. Inc., Richmond, Calif.
Jaeger Machine Co., 550 W. Spring St., Columbus 16, Ohio.
Jarrell-Ash Co., 28 Farwell St., Newtonville 60, Mass.
Jefferson Union Co., 31 Fletcher Ave., Lexington, Mass.
Jeffrey Mfg. Co., 974 N. Fourth St., Columbus 16, Ohio.
Jenkins Bros., 100 Park Ave., New York 17, N.Y.
Jesco Lubricants Co., P.O. Box 7331 Kansas City 16, Mo.
Jessop Steel Co., 538 Green St., Washington, Pa.
Jet-Lube, Inc., 3093 North California St., Burbank, Calif.
Johns-Manville, 22 E. 40th St., New York 16, N.Y.
Johnson Aircraft Co., 39 Hanover Ave., Morris Plains, N.J.
Johnson Belting Co., 44 Hubert St., New York 13, N.Y.
Johnson Bronze Co., 492 S. Mill St., New Castle, Pa.
Johnson Corp., 816 Wood St., Three Rivers, Mich.
Johnson Co., C. S., P. O. Box 71, Champaign, Ill.
Johnson Co., R. G., 831 Wash. Trust Bldg, Washington, Pa.
Johnson Loading Supplies, G. R., 5026 Butterworth Rd., Mercer Island, Wash.
Johnson-March Corp., 1724 Chestnut St., Philadelphia 3, Pa.
Johnson Plastic Corp., 201 Brown Rd., Chagrin Falls, Ohio
Johnston-Morehouse-Dickey Co., 704 Second Ave., Pittsburgh 19, Pa.
Johnston Pump Co., 3272 E. Foothill Blvd., Pasadena 8, Calif.
Jones & Laughlin Steel Corp., 3 Gateway Center, Pittsburgh 30, Pa.
Jordan Corp., Div. OPW Corp., 6013 Wiehs Rd., Cincinnati 13, Ohio
Joy Mfg. Co., Henry W. Oliver Bldg., Pittsburgh 22, Pa.
Joyce-Cridland Co., 2027 E. First St., Dayton, Ohio.
Judsen Rubber Works, Inc., 4107 West Kinzie St., Chicago 24, Ill.
Justrite Mfg. Co., 2061 Southport Ave., Chicago 14, Ill.

K

Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, Calif.
Kaiser Engineers, 1924 Broadway, Oakland, Calif.
Kanawha Mfg. Co., 1520 Dixie St., Charleston 1, W. Va.
Kansas City Hay Press, 801 Woodswether Rd., Kansas City, Mo.
Kato Engineering Co., Mankato, Minn.
Kaydon Engineering Corp., Muskegon, Mich.
Keasbey & Mattison Co., Ambler, Pa.
Keeney Co., Paul E., 1125 S. E. Grand Ave., Portland 14, Ore.
Keeler Co., E., 238 West St., Williamsport 3, Pa.
Kellogg Co., M. W., 711 Third Ave., New York 17, N. Y.
KENNAMETAL INC., MINING TOOL DIV., Bedford, Pa. Page 189.
Kenco Pump Div., American Crucible Products Co., 1305 Oberlin Ave., Lorain, Ohio.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Kennedy-Van Saun Mfg. & Eng. Corp., 2 Park Ave., New York, N. Y.
Kensington Steel Co., 505 Kensington Ave., Chicago 28, Ill.
Kenyon Walker Machinery Co., 1600 11th St., Denver 2, Colorado.
Kerite Co., 30 Church St., New York 7, N. Y.
KERN INSTRUMENTS, INC., 120 Grant St., P. O. Box 727, White Plains, N. Y. Page 207.
Kersey Mfg. Co., Inc., P. O. Box 151, Bluefield, Va.
Keuffel & Esser Co., 300 Adams St., Hoboken, N. J.
Keystone Carbon Co., State St., St. Marys, Pa.
Keystone Lubricating Co., 21st & Clearfield Sts., Philadelphia 32, Pa.
Keystone Valve Corp., P. O. Box 6716, 5325 Kirby Dr., Houston 5, Texas.
Kidde & Co., Inc., Walter, 956 Main St., Belleville 9, N.J.
Kieley & Mueller, Inc., 64 Gemung St., Middletown, N. Y.
Killark Electric Mfg. Co., 3940 Easton Ave., St. Louis, Mo.
King Powder Co., 1703 First National Bank Bldg., Cincinnati 2, Ohio.
Kintel, 5725 Kearny Villa Rd., San Diego, Calif.
Kirk & Blum Mfg. Co., 3150 Forrer St., Cincinnati 9, Ohio.
Kistler Instrument Corp., North Tonawanda, N. Y.
Klemp Metal Grating Corp., 6613 S. Melvina Ave., Chicago 38, Ill.
Klipfel Valves, Inc., 1075 Lincoln Ave. Hamilton, Ohio.
Klochner-Humboldt-Deutz AG, Cologne, Germany.
Knopp, Inc., 1307 66th St., Oakland 8, Calif.
Kobe, Inc., 3040 E. Slauson Ave., Huntington Park, Calif.
Koebel Diamond Tool Co., 9456 Grinnell, Detroit 13, Mich.
Koehring Co. 3026 West Concordia, Milwaukee 16, Wis.
Kolton Electric Mfg. Co., 123 New Jersey R. R. Ave., Newark 5, N. J.
Koppers Co., Inc., Metal Prod Div., 200 Scott St., Baltimore 30, Md.
Koppers Co. Inc., Koppers Bldg., Pittsburgh 19, Pa.
Korb-Pettit Wire Fabrics & Iron Works. 1501-15 N. Mascher St., Philadelphia 22, Pa.
Kraft Bag Corp., 630 Fifth Ave. New York, N. Y.
Kremser & Sons, Inc., Frank A. P. O. Box 6207, Holmesburg Sta., Philadelphia 36, Pa.
Krogh Pump & Equipment Co., Inc., 515 Harrison St., San Francisco 5, Calif.
Kuhlman Electric Co., 26th & Jefferson Sts., Bay City, Mich.
Kurz & Root Co., 232 E. North Island St. Appleton, Wis.
Kwik-Mix Co., Koehring Div., 235 W. Grand Ave., Port Washington, Wis.
K. W. Battery Co., 3555 Howard St., Skokie, Ill.
KW-DART TRUCK CO., 2621 Oak St., Kansas City, Mo., Page 211.

L

Laclede-Christy Works, Refractories Div., H. K. Porter Co., Inc., 2500 First National Bank Bldg., Pittsburgh 22, Pa.
Ladish Co., Cudahy, Wis.
Lainiere De Sclessin, Sclessin, Belgium.
Lake Shore, Inc., Lake Shore Engineering Div., Iron Mountain, Mich.
Lake Shore Electric Mfg. Corp., 207 Willis St., Bedford, Ohio.
Lakeside Bridge & Steel Co., 5306 North 33rd St., Milwaukee 9, Wis.
Lamson Corp. 210 Lamson St., Syracuse 1, N. Y.
Lamson & Sessions Co., 5000 Tiedeman Rd., Cleveland 9, Ohio.
Landis Steel Co., 116 West A St., Box 248, Picher, Okla.
Laramie Chemical Corp., 290 Main St., Stamford, Conn.
Laubenstein Mfg. Co., 422 S. Third St., Ashland, Pa.
Lawrence Pumps, Inc. 371 Market St., Lawrence, Mass.
Laylander. Philip A., Box 4395, Tucson, Ariz.
Layne & Bowler Pump Co. of Los Angeles, 2943 South Vail Ave., Los Angeles 22, Calif.
Leavitt Machine Co., Orange, Mass.
Lebanon Steel Foundry, Lebanon, Pa.
Le Bus International Engineers, Inc., Box 23525 Longview, Tex.
Lebus Mfg. Co., Subsidiary of American Hoist & Derrick Co., Longview, Texas.
Lecco Machinery & Engineering Co., Box 3036, Bluefield, West Va.
Lecourtenay Co., 5 Maine St., Newark 5, N. J.
Ledoux & Co., 359 Alfred Ave., Teaneck, N. J.
Ledeen, Inc., 3350 North Gilman Rd., El Monte Calif.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia 44, Pa.
Lee-Norse Co., 751 Lincoln Ave., North Charleroi, Pa.
Leetonia Tool Co., 142 Main St., Leetonia, Ohio.
Leffel & Co., James, 426 East St., Springfield, Ohio.
LE-HI Div., Hose Accessories Co., 17th St & Lehigh Ave., Philadelphia 32 Pa.
Leland Electric Co., Div. American Machine & Foundry Co., 1501 Webster St., Dayton 1, Ohio.
Le Roi Div., Westinghouse Air Brake Co., Milwaukee 1, Wis.
Leschen Wire Rope Div., H. K. Porter Co., Inc., 2727 Hamilton Ave., St. Louis 12, Mo.
LE TOURNEAU-WESTINGHOUSE CO., P. O. Box 240, Peoria, Ill. Pages 141, 143.
LeTourneau, Inc., R. G. 4014 S. MacArthur St., Longview, Texas
Leupold & Stevens Instruments Inc., 4445 N. E. Glisan St., Portland 13, Ore.
Lewellen Mfg. Co., 1428 Tenth St., Columbus, Ind.
Lewis Bolt & Nut Co., 504 Malcolm Ave., S. E., Minneapolis 14, Minn.
Lidgerwood Industries, Inc., 7 Dey St., New York, N. Y.
Lilie-Hoffmann Cooling Towers, Inc. 1450 S. Vandeventer, St. Louis 10, Mo.
Lima Electric Motor Co., Findlay Rd., Lima, Ohio.
LINATEX CORP. OF AMERICA. Rockville, Conn. Page 182.
Lincoln Electric Co., 22801 St. Clair Ave., Cleveland 17, Ohio.
Lincoln Engineering Co. Div., McNeil Machine & Engineering Co., 5701 Natural Bridge, St. Louis 20, Mo.
Linde Co., Union Carbide Corp. 30 East 42 St. New York 17, N. Y.
Line Material Industries, McGraw-Edison Co., 700 W. Michigan St., Milwaukee 1, Wis.
LINK-BELT CO., DEPT. EMJ-58, Prudential Plaza, Chicago 1, Ill. page 151.
Link-Belt Speeder Corp., 1201 6th St., S.W., Cedar Rapids, Iowa.
Lippmann Engineering Works, Inc., 4603 W. Mitchell St. Milwaukee, Wis.
Liquid-Solid Seprations, Ltd., 2 Anderson St., London S.W. 3, England.
Lister-Blackstone, Inc., 42-32 21st St., Long Island City 1, N. Y.
Lockrey Co., Lubricants Div., Southampton, N. Y.
Lonergan Co., J. E., Second & Race Sts., Philadelphia 6, Pa.
LOGAN ENGINEERING CO., 4901 West Lawrence St. Chicago 30, Ill. Page 172.
Long Co., Box 331, Oak Hill, W. Va.
Longyear Co., E. J., 1700 Foshay Tower, Minneapolis 2, Minn.
Los Angeles Steel Casting Co., 6100 South Boyle, Los Angeles 58, Calif.
Louden Machinery Co., 607 Broadway, Fairfield, Iowa.
Lovejoy Flexible Coupling Co., 4932 W. Lake St., Chicago 44, Ill.
Ludwig Inc. F. G., 105 Coulter Street, Old Saybrook, Conn.
Ludlow-Saylor Wire Cloth Co., 634 S. Newstead, St. Louis 10, Mo.
Lufkin Rule Co., 1730 Hess Ave., Saginaw, Mich.
Lukens Steel Co., Coatesville, Pa.
Lumen Bearing Co., 197 Lathrop St., Buffalo 12, N.Y.
Lundberg Explorations Ltd., 96 Eglinton Ave. E., Toronto, Ontario Canada.
Lunkenheimer Co., Beekman St. & Waverly Ave., Cincinnati 14, Ohio.
Luzerne Rubber Co., Muirhead & Dewey Sts., Trenton 7, N. J.

M

Macbeth Daylighting Corp., Newburgh, N. Y.
Mace Co., 2763 Blake St., Denver 5, Colo.
MACHINERY CENTER INC., P. O. Box 964—1201 South 6th West, Salt Lake City 10, Utah. Page 215.
MACK TRUCKS INC., 1355 West Front St., Plainfield, N. J. Page 203.
Macklin Co., 1936 Lawrence Blvd., Jackson, Mich.
Macwhyte Wire Rope Co., 2937 14th Ave., Kenosha, Wis.
Madesco Tackle Block Co., Easton, Pa.
Magnetic Engineering & Mfg. Co., 852 Van Houten Ave., Clifton, N. J.
MAGOR CAR CORP., 50 Church St., New York 7, N. Y. Pages 174-175.
Mahon Co. R. C., P. O. Box 4666, Detroit 34, Mich
Majac, Inc., 23rd St., Sharpsburg, Pittsburgh 15, Pa.
Mallinckrodt Chemical Works, 2nd & Mallinckrodt Sts., St. Louis 7, Mo.
Mancha Storage Battery Locomotive Div., Goodman Mfg. Co., Halsted St. & 48th Pl., Chicago 9, Ill.
Manganese Steel Forge Co., Allen St. & Castor Ave., Philadelphia 34, Pa.
Manheim Mfg. & Belting Co., 470 Stiegel St. Manheim, Pa.
Manitowoc Engineering Corp., South 16th St., Manitowoc, Wis.
Manning Co., Charles E., 4700 Clairton Blvd., Pittsburgh, Pa.
Manning, Maxwell & Moore, Inc., Shaw Box Crane & Hoist Div., Muskegon, Mich.
Manu-Mine Research & Devel. Co., P. O. Box 167, Reading Pa.
Manzel Div., Houdaille Industries, Inc., 315 Babcock St., Buffalo 10, N. Y.
Marathon Coal Bit Co., Inc., Montgomery, W. Va.
Marathon Corp., Chemical Sales Dept., Rothschild, Wis.
Marathon Electric Mfg. Corp., Wausau, Wis.
Marble Card Electric Corp., Superior St., Gladstone, Mich.
Marietta Concrete Corp., Dept. B, Marietta, Ohio.
Marion Metal Products Co., Cheney Ave., Marion, Ohio.
Marion Power Shovel Co., Marion, Ohio.
Markley Dust Control System, Inc., 80 Snyder Rd., Ramsey, N. J.
Marland One-Way Clutch Co., Elm Ave., & Washington St., La Grange, Ill.
Marley Co., 222 West Gregory Blvd., Kansas City 14 Mo.
Marlin-Rockwell Corp., 402 Chandler St., Jamestown, N. Y.
Marlow Pumps Div., Bell & Gossett Co., Box 200, Midland Park, N. J.
Marmon-Herrington Co., 1511 West Washington St., Indianapolis 7, Ind.
Marquette Mfg. Co., Inc., 307 E. Hennepin Ave., Minneapolis 14, Minn
Marsh Enginering Co., E. F., 4324 W. Clayton Ave., St. Louis 10, Mo.
Martin Engineering Co., Neponset, Ill.
Martin Fan & Blower Co., 4634 W. 21st Pl., Chicago 50, Ill.
Marvel Engineering Co., 7227 N. Hamlin Ave., Chicago 45, Ill.
Maschinenfabrik Rudolf Hausherr & Soehne, GmbH, c/o B. J. Nykerk Corp., 42 Broadway, New York 4, N. Y.
Massachusetts Gear & Tool Co., Div. of Geartronics Corp., 46 Nashua St., Woburn, Mass.
Master Bronze Powder Co., Inc., 538-548 West State St., Calumet City, Ill.
Master Builders Co., 7016 Euclid Ave., Cleveland 3, Ohio.
Master Electric Co., 126 Davis Ave., Dayton 1, Ohio.
Master Mfg. Co., Hutchinson, Kan.
Matronics, Inc., New York, N. Y.
Maxi Corp., P. O. Box 3129 Terminal Annex, Los Angeles 54, Calif.
Mayhew Machine & Supply Co., P. O. Box 7726, Dallas, Tex.
MAYO TUNNEL & MINE EQUIPMENT, Box 1413, Lancaster, Pa. Page 206.
McClintock Co., R. S. W. 418 Second Ave., Spokane, Wash.
McDonald Drilling Co., Inc., 14408 St. Marys Ave., Detroit 27, Mich.
McDonald Mfg. Co., A. Y., 12th & Pine Sts., Dubuque, Iowa.
McDowell Co., Inc., 3203 W. 71 St., Cleveland 2, Ohio.
McDowell Mfg. Co., Pittsburgh 9, Pa.
McGill Mfg. Co., Inc., 1151 N. Lafayette St., Valparaiso, Ind.
ABCs Scale Div., McDowell Co., Inc., 16300 Waterloo Rd., Cleveland 10, Ohio.
McGowan Pump Div., Leyman Mfg. Corp., 3401 Central Parkway, Cincinnati 25, Ohio.
McGowan Pump Div., Leymann Mfg. Corp., 58 Central Ave., Cincinnati 2, Ohio.
Lectromelt Furnace Div., McGraw-Edison Co., P. O. Box 1257, Pittsburgh 30, Pa.
McKee & Co., Arthur G., 2300 Chester Ave., Cleveland 1, Ohio.
McKenzie & Whittle, Carlsbad, N. M.
McKiernan-Terry Corp., 505 Manor Ave., Harrison, N. J.
McKinney Drilling Co., P. O. Box 190, Nacogdoches, Tex.
McLanahan & Stone Corp., Hollidaysburg, Pa.
McMillan's Sons, W. H., 49 South St., New York, N. Y.
McNally Pittsburg Mfg. Corp., 307 W. Third St., Pittsburg, Kan.
McPhar Geophysics, Ltd., 139 Bond Ave., Don Mills, Ontario, Canada.
McPhar Manufacturing, Ltd., 139 Bond Ave., Don Mills, Ontario, Can.
Mead Mill Co., 14736 Charlevoix Ave., Detroit 15, Mich.
Meckum Engineering, Inc., 53 W. Jackson Blvd., Chicago 4, Ill.
Meckum Engineering, Inc., Dayton Rd., Ottawa, Ill.
Meeker Foundry Co., 95 Clay St., Newark 4, N. J.
Memco Engineering & Mfg. Co., Commack, N. Y.
Menlo Research Laboratory, 538 Phelan Ave., San Jose, Calif.
Meriam Instrument Co., 10920 Madison Ave., Cleveland 2, Ohio.
MERRICK SCALE MFG. CO., 184 Autumn St., Passaic, N. J. Page 214.
Metal Carbides Corp., 107 East Indianola Ave., Youngstown 7, Ohio.
Metal & Thermit Corp., Rahway, N. J.
Metal Traders Inc., 67 Wall St., New York, N. Y.
Metallizing Engineering Co., Inc., 1101 Prospect Ave., Westbury, N. Y.
Metallo Gasket Co., 12 Bethany St., New Brunswick, N. J.
Metallurgical Products Dept., General Electric Co., 11177 East Eight Mile Rd., Detroit 32, Mich.
Metron Instrument Co. 432 Lincoln St., Denver, Colo.
Mexico Refractories Co., Mexico, Mo.
Michigan Chemical Corp., Saint Louis, Michigan.
Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.
Midvale-Heppenstall, 4301 Wissahickon Ave., Philadelphia 40, Pa.
Miehle Printing Press & Mfg. Co., Star-Kimble Motor Div., 200 Bloomfield Ave., Bloomfield, N. J.
Miller & Associates. David, Box 572, Beverly Hills, Calif.
Miller Equipment Co., Inc., 13 & New Sts., Franklin (Venango County), Pa.
Milwaukee Electric Tool Corp., 5316 W. State St., Milwaukee 8, Wis.
MINE & SMELTER SUPPLY CO., Marcy Mill Div., P. O. Box 9041, Denver 16, Colo. Page 142.
MINE SAFETY APPLIANCES CO., 201 North Braddock Ave., Pittsburgh 8, Pa. Pages 178-179.
Minerals Engineering Co., 801 Fourth Ave., Grand Junction, Colo.
Miners' Hardware Supply Co., 806 Republic Bldg., Pittsburgh 12, Pa.
Mining Machine Parts, Inc., 2701 St. Clair Ave., Cleveland 14, Ohio.
Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne & Windrim Aves., Philadelphia 44, Pa.
Minneapolis-Honeywell Regulator Co., 2753 Fourth Ave., S., Minneapolis 8, Minn.
Minneapolis Honeywell Regulator Co., Brown Instrument Div., Wayne & Windrim Aves., Philadelphia 44, Pa.
Minnesota Mining & Mfg. Co., 900 Bush Ave., St. Paul 6, Minn.
Mission Mfg. Co., P. O. Box 4209, Houston, Texas
Missouri Belting Co., 1029 S. Grand Blvd., St. Louis 4, Mo.
Mixing Equipment Co., 234-n Mt. Read Blvd., Rochester 11, N. Y.
Mobile Aerial Towers, Inc., Ft. Wayne, Ind.
MOBILE DRILLING, INC., 960 N. Pennsylvania St., Indianapolis 4, Ind. Opposite Page 18.
MOBILE DRILLING & ENGINEERING INC., DIV. MOBILE DRILLING INC.

960 N. Pennsylvania St., Indianapolis 4, Ind.
MOBILE BUMPER INC., DIV. MOBILE DRILLING INC., 960 N. Pennsylvania St., Indianapolis 4, Ind.
Moloney Electric Co., 5390 Bircher Blvd., St. Louis 20, Mo.
MONSANTO CHEMICAL CO., 1700 S. Second St., St. Louis 4, Mo. Page 165.
Moore Co., 424 Nichols Rd., Kansas City 12, Mo.
Moore Co., 1036 Quarrier St., Charleston, W. Va.
Moore Drop Forging Co., 38 Walter St., Springfield 7, Mass.
Moran Engineering Co., 7721 E. Jefferson St., Paramount, Calif.
Morco, Inc., 22201 Aurora Rd., Bedford, Ohio.
Morgardshammars Mak Verkstads, Morgardshammar, Sweden.
MORRIS MACHINE WORKS, Baldwinsville, N. Y. Page 199.
Morse Bros. Machinery Co., P. O. Box 1708, Denver, Colo.
Morse Chain Co., A Borg-Warner Industry, Ithaca, N. Y.
Morton Salt Co., 120 S. LaSalle St., Chicago 3, Ill.
Motorola Communications & Electronics, Inc., 4501 Augusta Blvd., Chicago 51, Ill.
Mott Core Drilling Co., 830 Eighth Ave., Huntington, W. Va.
Mt. Sopris Instrument Co., 1320 Pearl St., Boulder, Colo.
Mueller Brass Co., 1925 Lapeer Ave., Port Huron, Mich.
Multi Electrical Mfg. Co., 4243 W. Lake St., Chicago 24, Ill.
Multi-Metal Wire Cloth Co., Inc., 1350 Garrison Ave., New York 59, N. Y.
Mullite Works, Refractories Div., H. K. Porter Co., Inc., Canal St., Shelton, Conn.
Murphy Diesel Co., 5317 W. Burnham St., Milwaukee 11, Wis.
Mustang Motor Products Corp., Box 1191, 635 West Colorado Blvd., Glendale 4, Calif.
Myers-Whaley Co., Inc., P. O. Box 789, Knoxville 1, Tenn.

N

NACHOD & U. S. SIGNAL CO., 4777 Louisville Ave., Louisville 9, Ky. Page 200.
NAGLE PUMPS, INC., 1239 Center St., Chicago Heights, Ill. Page 188.
Nash Engineering Co., 218 Wilson Rd., South Norwalk, Conn.
National Carbon Co., Union Carbide Corp., 30 East 42 St., New York 17, N. Y.
National Cylinder Gas Co., 840 N. Michigan Ave., Chicago 11, Ill.
National Electric Products Corp., Gateway Center, 140 Stanwix St., Pittsburgh 22, Pa.
National Filter Media Corp., 1717 Dixwell Ave., New Haven 11, Conn.
National Fuse & Powder Co., 3801 Delgany St., Denver 5, Colo.
NATIONAL IRON CO., Ramsey St. & 50th Ave. W., Duluth 7, Minn. Page 191.
National Lead Co., 111 Broadway, New York 6, N. Y.
National Mine Service Co., 1260 Maple St., Indiana 19, Pa.
NATIONAL MALLEABLE & STEEL CASTINGS CO., 10606 Quincy Ave., Cleveland 6, Ohio. Page 171.
National Powder Co., Eldred, Pa.
NATIONAL SUPPLY CO., Two Gateway Center, Pittsburgh, Pa., Page 176.
National Tank & Pipe Co., 2301 N. Columbia Blvd., Portland 3, Ore.
National Vulcanized Fibre Co., Box 311, Wilmington 99, Del.
National Welding & Mfg. Co., 690 Cedar St., Newington, Conn.
NAYLOR PIPE CO., 1243 E. 92nd St., Chicago 19, Ill. Page 128.
Neff & Fry Co., Camden, Ohio.
New Departure Div., General Motors Corp., Bristol, Conn.
New Jersey Meter Co., Plainfield, N. J.
New Jersey Zinc Co., 160 Front St., New York 7, N. Y.
New York Air Brake Co., Aurora Pump Div., 86 Loucks St., Aurora, Ill.
New York Belting & Packing Co., 1 Market St., Passaic, N. J.
New York Engineering Co., 75 West St., New York 6, N. Y.
New York & New Jersey Lubricant Co., 292 Madison Ave., New York 17, N. Y.
New York Rubber Corp., 100 Park Ave., New York 17, N. Y.
Newage Industries, Inc., 222 York Road, Jenkintown, Pa.
Newark Wire Cloth Co., 370 Verona Ave., Newark 4, N. J.
Newcomer Products, Inc., Latrobe, Pa.
Newhall Chain Forge & Iron Co., 11 Orchard Rd., Park Ridge, N. J.
Nice Ball Bearing Co., 30th & Hunting Park Ave., Philadelphia 40, Pa.
NICHOLS ENGINEERING & RESEARCH CORP., 70 Pine St., New York 5, N. Y. Page 173.
Nife, Inc., Lambert Ave., Copiague, N. Y.
Nolan Co., 120 Pennsylvania St., Bowerston, Ohio.
NORDBERG MFG. CO., 3073 S. Chase Ave., Milwauke 1, Wis. Pages 16-17.
Norden-Ketay Corp., Milford, Conn.
Norma-Hoffman Bearings Corp., Stamford, Conn.
North American Philips, Co., Inc. 750 South Fulton Ave., Mount Vernon, N. Y.
North American Refractories Co., E. 6th at Euclid Ave., Cleveland 14, Ohio.
NORTHERN BLOWER CO., 6410 Barberton Ave., Cleveland, Ohio. Page 186.
Northern Conveyor Co., P. O. Box 46, Janesville, Wis.
Northwest Engineering Co., 135 S. La Salle St., Chicago 3, Ill.
Northwestern Electric Co., 1750 N. Springfield Ave., Chicago 47, Ill.
Norton Co., 1 New Bond St., Worcester 6, Mass.
Novo Pump & Engine Co., 702 Porter St., Lansing 5, Mich.
Nuclear-Chicago Corp., 223 W. Erie St., Chicago, Ill.
Nuclear Exploration Co., 826 East 7th St., Los Angeles 21, Calif.
Nuclear Research Corp., Second St. Pike, Southampton, Pa.

O

O. K. Machinery Div., John C. Motter Printing Press Co., Columbia, Pa.
Ogden Iron Works, 185 23 St., Ogden, Utah.
Ohio Brass Co., Mansfield, Ohio.
Ohio Carbon Co., 12508 Berea Rd., Cleveland 11, Ohio.
Ohio Forge & Machine Corp., 3010 Woodhill Rd., Cleveland 4, Ohio.
Ohio Gear Co., 1333 E. 179th St., Cleveland 10, Ohio.
Ohio Grease Co., 525 N. Spring St., Loudonville, Ohio.
Ohio Injector Co., 275 Main St., Wadsworth, Ohio.
Ohio Locomotive Crane Co., 1816 Southern Ave., Bucyrus, Ohio.
Ohio Oil Co., 539 South Main St., Findlay, Ohio.
Oilgear Co., 1560 W. Pierce St., Milwaukee 4, Wis.
Okadee Co., 332 S. Michigan Ave., Chicago 4, Ill.
Okonite Co., 220 Passaic St., Passaic, N. J.
Olds Alloy Co., 4481 Mason St., South Gate, Calif.
Olin-Mathieson Chemical Corp., Explosive Div., East Alton, Ill.
Oliver Corp., 400 West Madison, Chicago 6, Ill.
Oliver Corp., A. B. Farquhar Div., 142 N. Duke St., York, Pa.
Omega Machine Co., Div., B-I-F Industries, 345 Harris Ave., Providence 1, R. I.
Onan & Sons, Inc., D. W. University Ave. S. E. at 25th, Minneapolis 14, Minn.
Ore & Chemical Corp., 80 Broad St., New York, N. Y.
Orange Roller Bearing Co., Inc., 557 Main St., Orange, N. J.
Oronite Chemical Co., 200 Bush St., San Francisco, Calif.
Orton Crane & Shovel Co., 608 S. Dearborn St., Chicago 5, Ill.
Ortruc, Inc., Mount Carmel, Illinois.
Osborn Manufacturing Co., Hamilton & Marquette Sts., Cleveland 14, Ohio.
Oshkosh Motor Truck, Inc., 2300 Oregon St., Oshkosh, Wis.
Omose Wood Preserving Co., 980 Ellicott St., Buffalo 9, N. Y.
Ottumwa Box Car Loader Co., Ottumwa, Iowa.
Overseas Raw Materials Corp., 11 Broadway, New York, N. Y.
Overstrom & Sons, Inc., 2213 West Mission Rd., Alhambra, Calif.
Owatonna Tool Co., 353 Cedar St., Owatonna, Minn.
Owen Bucket Co., 6001 Breakwater Ave., Cleveland 2, Ohio.
Oxy-Catalyst, Inc., Wayne, Pennsylvania.
Ozalid Div., General Aniline & Film Corp., Ansco Rd., Johnson City, N. Y.

P

Pacific Coast Enginering Co., Oak and Clement Sts., Alameda, Calif.
Pacific Foundry Co., Ltd., 3100—19th St., San Francisco 10, Calif.
Packsack Diamond Drills, Ltd., 1385 Hammond St., North Bay, Ontario, Canada.
Pacific Lumber Co., 100 Bush St., San Francisco, Calif.
Pacific Wire Rope Co., 1840 E. 15th St., Los Angeles 21, Calif.
Pacific Wood Tank Corp., 461 Market St., San Francisco 5, Calif.
Page Engineering Co., Clearing Post Office, Chicago 38, Ill.
Palnut Co., Glen Rd., Mountainside, N.J.
Pangborn Corp., 630 Pangborn Blvd., Hagerstown, Md.
Paragon Electric Co., 1600 12 St., Two Rivers, Wis.
Paragon-Revolute Corp., 97 South Ave., Rochester 4, N. Y.
Parker Electrical Mfg. Co., 221 Washington St., Oakland 7, Calif.
Parker Safety Equipment Co., 785 Lyons Ave., Irvington 11, N. J.
Partrick & Wilkins Co., 51 N. 7th St., Philadelphia 6, Pa.
Patterson Foundry & Machine Co., P. O. Box 743, East Liverpool, Ohio.
Pattin Manufacturing Co., P. O. Box 527, Marietta, Ohio.
Patton Mfg. Co., Inc., 1802 W. Pleasant St., Springfield, Ohio.
Paulsen-Webber Cordage Corp., 170 John St., New York, N. Y.
Pease Co., C. F. 2601 W. Irving Park Rd., Chicago, Ill.
Peck & Harvey Mfg. Corp., 5650 North Western Ave., Chicago 45, Ill.
Peerless Electric Co., 1401 W. Market St., Warren, Ohio.
Peerless Photo Products, Inc., Shoreham, N. Y.
Penberthy Mfg. Co., 1242 Holden Ave., Detroit 2, Mich.
Pendleton Woolen Mills, Washougal, Wash.
Peninsular Grinding Wheel Div., 729 Meldrum Ave., Detroit 7, Mich.
Penn Machine Co., 106 Station St., Johnstown, Pa.
Penn Mfg. & Supply Co., 45 Westminster St., Wilkes-Barre, Pa.
Pennsalt Chemicals Corp., 3 Penn Center, Philadelphia 2, Pa.
Pennsylvania Crusher Div., Bath Iron Works Corp., Rm. 1712, West Chester, Pa.
Pennsylvania Drilling Co., 1201 Chartiers Ave., Pittsburgh 20, Pa.
Pennsylvania Pump & Compressor Co., Easton, Pa.
Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.
Perkins Machine & Gear Co., West Springfield, Mass.
Permaglie Corp. of America, 37-23 33rd St., Long Island City 1, N. Y.
Permold Co., 800 W. Liberty St., Medina, Ohio.
Permutit Co., Div., Pfaudler Permutit, Inc., 50 W. 44th St., New York 36, N. Y.
Peterson Filters & Engr. Co., 137 Social Hall Ave., Salt Lake City 1, Utah.
Pettibone Mulliken Corp., 4710 W. Division St., Chicago 51, Ill.
Pettinos, Inc., George F., 1206 Locust St., Philadelphia 7, Pa.
Phelps Dodge Copper Products Corp., 300 Park Ave., New York 22, N. Y.
Philadelphia Belting Co., 6th & Spring Garden Sts., Philadelphia 23, Pa.
Philadelphia Gear Corp., G St. & Erie Ave., Philadelphia 34, Pa.
Philadelphia Quartz Co., 1135 Public Ledger Bldg., Philadelphia 6, Pa.
Phillips Bros., Inc., 70 Pine St., New York 5, N. Y.
Phillips Electronics, Inc., Instruments Div., 750 S. Fulton Ave., Mt. Vernon, N. Y.
Phillips Petroleum Co., Bartlesville, Okla.
Phoenix Products Co., Inc., 4735 N. 27th St., Milwaukee, Wis.
Pickard Industries, Inc., Central Mine Supply Co., Div., Mt. Vernon, Ill.
Pioneer Engineering Div., Ponr & Co., Inc., 3200 Como Ave., Minneapolis 14, Minn.
Pitkin, Inc., Lucius, 47 Fulton St., New York 38, N. Y.
Pitnam Electric Products Co., Power Cable Dept., 261 Madison Ave., New York 16, N. Y.
Pitman Mfg. Co., 300 W. 79 Terrace, Kansas City 14, Mo.
Pittsburgh Electrical & Machine Works, 1130 N. Franklin St., Pittsburgh 33, Pa.
Pittsburgh Gear Co., 27th and Smallman Sts., Pittsburgh 22, Pa.
Pittsburgh Reflector Co., Oliver Bldg., Pittsburgh 22, Pa.
Pittsburgh Screw & Bolt Co., P. O. Box 1708, Pittsburgh 30, Pa.
Pittsburgh Steel Co., 1600 Grant Bldg., Pittsburgh 30, Pa.
Plan Hold Corp., 5204 Chakemco St., South Gate, Calif.
Plastex Co., 3232 Cleveland Ave., Columbus 24, Ohio.
Plymouth Locomotive Works Div., Fate-Root-Heath Co., Plymouth, Ohio.
Plymouth Rubber Co., 51 Revere St., Canton, Mass.
Pollock Co., William B., 101 Andrews Ave., Youngstown, Ohio.
Poole Foundry & Machine Co., 1700 Union Ave., Baltimore 11, Md.
Porta-Trace, Inc., 342 Clinton Street, Binghamton, New York.
Porto Pump Inc., 19735 Ralston, Detroit 3, Mich.
Porter-Cable Machine Co., 700 Marcellus St., Syracuse 4, N. Y.
Post Co., Frederick, 3650 N. Avondale Ave., Chicago 18, Ill.
Powell Co., Wm., 2525 Spring Grove Ave., Cincinnati 22, Ohio.
Powercraft Corp., 2215 De Kalb St., St. Louis 4, Mo.
Precision Grinding Wheel Co., Inc., 8301 Torresdale Ave., Philadelphia 36, Pa.
Precision Radiation Instruments, Inc., 4223 West Jefferson Blvd., Los Angeles 16, Calif.
Precision Thermometer & Instrument Co., 1434 Brandywine St., Philadelphia 30, Pa.
Preco, Inc., 6300 E. Slauson Ave., Los Angeles 22, Calif.
Prehy Co., 420 Lexington Ave., New York 17, N. Y.
Prime Mover Co., Muscatine, Iowa.
Princeton Gripholst, Inc., 32 George St., Boston 19, Mass.
Prins & Associates, K., Wellston, Ohio.
Process Engineering, Inc., Foot of Chase St., Methuen, Mass.
Product Development Co., Inc., 307 Bergen Ave., Kearny, N.J.
Productive Equipment Corp., 2926 W. Lake St., Chicago 12, Ill.
Proto Tool Co., 2209 Santa Fe Ave., Los Angeles 58, Calif.
Frank Prox Co., Inc., Terre Haute, Ind.
Pulmosan Safety Equipment Corp., 644 Pacific St., Brooklyn, N.Y.
Pulva Corp., 602 High St., Perth Amboy, N. J.
Pulverizing Machinery Div., Metals Disintegrating Co., Inc., Chatham Rd., Summit, N. J.
Punch-Lok Co., 321 North Justine St., Chicago 7, Ill.
Pure Carbon Co., 441 Hall Ave., St. Marys, Pa.
Pure Oil Co., 35 E. Wacker Drive, Chicago 1, Ill.
Purolator Products, Inc., 970 New Brunswick Ave., Rahway, N. J.
Pyle-National Co., 1328 N. Kostner Ave., Chicago 51, Ill.

Q

Quaker Rubber Div., H. K. Porter Co., Tacony & Comly Sts., Philadelphia 24, Pa.
Quay Industries, 2135 Riverside Avenue, Jacksonville 4, Fla.
Queen City Machine Tool Co., 3900 Kellogg Ave., Cincinnati 26, Ohio.
Quick Charge, Inc., 1750 N. E. 10th St., Oklahoma City, Okla.
Quick-Way Truck Shovel Co., P. O. Box 1800, Denver 1, Colo.
Quigley Co., Inc., 415 Madison Ave., New York 17, N. Y.

R

Radiac Co., Inc., 489 Fifth Ave., New York 17, New York.
Radiation Counter Laboratories, 5121 W. Grove St., Skokie, Ill.
Radio Corp. of America, Communications Products Dept., Camden 2, N. J.
Rankin Manufacturing Co., 616 S. Marengo Ave., Alhambra, Calif.
Rattan Mfg. Co., 550 State St., New Haven 7, Conn.
Rawson Electrical Instrument Co., 102 Potter St., Cambridge 42, Mass.
Ray-O-Vac Co., 212 E. Washington Ave., Madison 10, Wis.
Raybestos-Manhattan Inc., Manhattan Rubber Div., 42 Townsend St., Passaic, N. J.
Reading Crane & Hoist Corp., Box 1139, Reading, Pa.
Ready Power Co., 11231 Freud Ave., Detroit, Mich.
Red Jacket Co., Inc., 500 Bell Ave., Carnegie, Pa.
Reed-Curtis Nuclear Industries, Inc.,

655 W. Washington Blvd., Los Angeles 15, California.
Reed Roller Bit Co., Box 2119, Houston 1, Tex.
Reeves Pulley Co., Div., Reliance Electric & Engineering Co., 1225 Seventh St., Columbus, Ind.
Refractory & Insulation Corp., 120 Wall St., New York 5, N. Y.
REICH BROS. MFG. CO., 1439 Ash St., Terre Haute, Ind. Fourth Cover
Reintjes Co., George P., 2519 Jefferson St., Kansas City 6, Mo.
Reilly Tar & Chemical Corp., Merchants Bank Bldg., Indianapolis 4, Ind.
Reliance Electric & Engineering Co., 24701 Euclid Ave., Cleveland 17, Ohio.
Remington Arms Co., Inc., 939 Barnum Ave., Bridgeport 2, Conn.
Reo Motors, Inc., 1331 S. Washington St., Lansing 20, Mich.
Remington Rand Div., Sperry Rand Corp., 315 Fourth Ave.. New York 10, N. Y.
Republic Flow Meters Co., 2240 Diversey Pkwy., Chicago 47, Ill.
Republic Rubber Div., Lee Rubber & Tire Corp., Albert St., Youngstown, Ohio.
Republic Steel Corp., Republic Bldg., Cleveland 1, Ohio.
Republic Steel Corp., Truscon Steel Div., Albert St., Youngstown 1, Ohio.
Research-Cottrell. Inc., Bound Brook, N. J.
Resisto-Loy Co., Inc., 1251 Phillips Ave., S. W., Grand Rapids 7, Mich.
Resources Development Corp., 1640 Court Place, Denver, Colo.
Revere Copper & Brass, Inc., 230 Park Ave., New York 17, N.Y.
Revere Corp. of America, Wallingford, Conn.
Reynolds Metals Co., P. O. Box 2346-ZK, Richmond 18, Va.
Rhoads & Son, J. E., 2100 W. Eleventh St., Wilmington 99, Del.
RIBLET TRAMWAY CO., 1231 N. Washington St., Spokane, Wash. Page 186.
Rice Pump & Machine Co., Belgium, Wis.
Richards-Wilcox Mfg. Co., 1176—3rd St., Aurora, Ill.
Richardson Scale Co., Clifton, N. J.
Ridge Equipment Co., Fallentimber, Pa.
Ridge Tool Co., 400 Clark St., Elyria, Ohio.
Robbins & Myers, Inc., 1345 Lagonda Ave., Springfield, Ohio.
Roberts & Schaefer Co., Subsidiary of Thompson Starrett Co., Inc., Randolph-Wells Bldg., 130 North Wells St., Chicago 6, Ill.
Robinson Air-Activated Conveyor Systems, 80 Fifth Ave., New York 11, N. Y.
Robinson Clay Product Co., 65 West State St., Akron 9, Ohio.
Robinson Ventilating Co., Zelienople, Pa.
Rochester Ropes, Inc., Culpeper, Va.
Rockbestos Products Corp., Nicoll & Canner Sts., New Haven 4, Conn.
Rockford Bolt & Steel Co., 126 Mill St., Rockford, Ill.
Rockiron Co., Ltd., Sudbury, Ontario, Canada
Rockwell Co. W. S., 200 Eliot St., Fairfield, Conn.
Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8, Pa.
Rockwell Spring & Axle Co., Timken-Detroit Axle Div., 100 Clark St., Detroit 32, Mich.
Roebling's Sons Corp., John A., Sub. of Colorado Fuel & Iron Corp., 640 S. Broad St., Trenton 2, N. J.
ROGERS BROTHERS CORP., Albion, Pa. Page 214.
Rogers Iron Works Co., Joplin, Mo.
Rohm & Haas Co., 712 Locust St., Philadelphia, Pa.
Rollway Bearing Co., Inc., 541 Seymour St., Syracuse 4, N. Y.
Rome Cable Corp., 330 Ridge St., Rome, N. Y.
Root & Simpson, Inc., 1306 E. 17th Ave., Denver 1, Colo.
Roots-Connersville Blower Div., Dresser Industries. Inc., 900 West Mount St., Connersville, Ind.
Rose Mfg. Co., 2700 W. Barberry Place, Denver 4, Colo.
Ross Heat Exchanger Div., American Standard Box 2081 Buffalo 5. N.Y.
ROSS SCREEN & FEEDER CO., 100 Quimby St., Westfield, N. J. Page 162.
Round & Son Inc., David, P. O. Box 883, Cleveland 22, Ohio.
Ruberoid Co., 500 Fifth Ave., New York 36, N. Y.
Rust-Oleum Corp., 2425 Oakton St., Evanston, Ill.
Ruth Co., 1437 Blake St., Denver 2, Colo.
Ryerson & Son, Inc., Joseph T., 16 & Rockwell Sts., P. O. Box 8000 A, Chicago 80, Ill.

S

Safety Clothing & Equipment Co., 1990 E. 69th St., Cleveland 3, Ohio.
Safety First Supply Co., 425 Magee St., Pittsburgh 19, Pa.
Safety First Shoe Co., Inc., Holliston, Mass.
Saginaw Bearing Co., 821 South Water St., Saginaw, Mich.
St. Louis Malleable Casting Co., 7701 N. Conduit Ave., St. Louis 15, Mo.
St. Louis Screw & Bolt Co., 6900 North Broadway, St. Louis 15. Mo.
St. Regis Paper Co., 150 E. 42nd St., New York 17, N. Y.
Salem-Brosius, Inc., P. O. Box 2222, Pittsburgh 30, Pa.
Salem Tool Co., Salem, Ohio.
Samuel & Co., Inc., Frank, 2200 Philadelphia National Bank Bldg., Philadelphia 7, Pa.
Sanderson Cyclone Drill Co., E. Chestnut St., Orrville, Ohio.
Sandvik Steel Inc., Steel Belt Conveyor Dept., Fair Lawn, N. J.
Sanford-Day Iron Works, Inc., Dale Ave., P.O. Box 1511, Knoxville 9, Tenn.
Sangamo Electric Co., Springfield, Ill.
Santa Fe Tank Div., Fluor Products Co., 12000 E. Washington Blvd., Whittier, Calif.
Sauereisen Cement Co., 1242 Sharpsburg St., Pittsburgh 15, Pa.
SAUERMAN BROS., INC., 626 S. 28th Ave., Bellwood, Ill. Page 170.
Savage Co., W. J., 912 Clinch Ave., S. W., Knoxville 2, Tenn
Sawyer Belt Hook & Wedge Co., Inc. 16 Warren Ave., Pawtucket, R. I.
Scandinavia Belting Co., 744 Broad St., Box 464, Newark 1, N. J.
SCHAFFER POIDOMETER CO., 2828 Smallman St., Pittsburgh 22, Pa. Page 212.
Schatz Mfg. Co., Fairview Ave., Poughkeepsie, N. Y.
Schield Bantam Co., 221 Park St., Waverly, Iowa.
Schlueter Mfg. Co., St. Louis 7, Missouri.
Schneible Co., Claude B., P. O. Box 296 RP.A., Detroit 32, Mich.
Schonrock Mfg. Co., San Angelo, Tex.
Schramm, Inc., 870 E. Virginia Ave., West Chester, Pa.
Scientific Instruments Div., Beckman Instruments Inc., 2500 Fullerton Rd., Fullerton, Calif.
Scott Aviation Corp., Lancaster, N.Y.
Screen Equipment Co., Inc., 1750 Walden Ave., Buffalo 25, N. Y.
Schroeder Brothers Corp., Box 72 Nichol Ave., McKees Rocks (Pgh. Dist.), Pa.
Seiberling Rubber Co., Akron 9, Ohio.
Seismograph Service Corp., P. O. Box 1590, Tulsa 1. Okla.
Sellstrom Mfg. Co., 217 So. Hicks Rd., Palatine, Ill.
Shaft Constructors, Inc., P. O. Box 7695, Denver, Colo.
Shaft & Development Machines, Inc., 808 Newhouse Bldg., Salt Lake City 11, Utah.
Sharples Corp., 2300 Westmoreland St., Philadelphia 40, Pa.
Sheffield Div., Armco Steel Corp., Sheffield Station, Kansas City 25, Mo.
Shell Oil Co., 50 W. 50th St., New York 20, N. Y.
Shepard Niles Crane & Hoist Corp., Schuyler Ave., Montour Falls. N. Y.
Sheppard Co., Inc., R. H., Hanover, Pa.
Sherwin-Williams Co., 101 Prospect Ave. N. W., Cleveland 1, Ohio.
Shrader Co., F. W., 11623 S. Broadway, Los Angeles 61, Calif.
Shriver & Co., T., 848 Hamilton St., Harrison, N. J.
Shwayder Chemical Metallurgy Corp., 684 E. Woodbridge, Detroit 26, Mich.
Sight Feed Generator Co., West Alexandria, Ohio.
Sika Chemical Corp., 33-47 Gregory Ave., Passaic, N. J.
Sikorsky Div., United Aircraft Co., East Hartford. Conn
Silent Hoist & Crane Corp., 877—63rd St., Brooklyn 20, N. Y.
Silver Bells, Ltd., 600 16th Street, Oakland. California.
Simonds Saw and Steel Co., Fitchburg, Mass.
Simonds Worden White Co., Dayton 7, Ohio.
SIMPLEX WIRE & CABLE CO., 79 Sidney St., Cambridge 39, Mass. pp 122-123.
Simplicity Engr. Co., Durand, Mich.
Simplicity System Co., Riverside Drive, Chattanooga, Tenn.
Sinclair Refining Co., 600 Fifth Ave., New York, N. Y.
SKF Industries, Inc., P. O. Box 6731, Philadelphia 32, Pa.
Skinner Engine Co., 337 W. 12th St., Erie, Pa.
Skookum Co., Inc., 8504 N. Crawford St., Portland 3, Ore.
Slip-On, Inc., 401 Broadway, New York
Sly Mfg. Co., W. W., P. O Box 5939, Cleveland 1, Ohio
SMIDTH & CO., F. L., 11 West 42nd St., New York 36, N.Y., Page 126.
SMIT & CO., ANTON, 111 Eighth Ave., New York 11, N. Y. Page 212.
Smit & Sons, Inc., J. K., Murray Hill, N. J.
Smith-Emery Co, 781 E. Washington Blvd., Los Angeles 21, Calif.
Smith Engineering Works, 502 East Capital Dr., Milwaukee 12, Wis.
Smith Co., A. O., 3533 North 27th St., Milwaukee 1, Wis.
Smith & Co., Gordon, 445 College St., Bowling Green, Ky.
H. C. Smith Oil Tool Co., P. O. Box 431, Compton, Calif.
Smith & Serrell, Inc., 200 Washington St., Newark 2, N. J.
Smith Welding Equipment Corp., 2633 S. E. 4th St., Minneapolis 14, Minn.
Snap-on-Tools Corp., 8026 28 Ave., Kenosha, Wis.
Snell, Inc., Foster D., 29 W. 15th St., New York 11, N. Y.
Snow-Nabstedt Gear Corp., 251 Welton St., Hamden 7. Conn.
Snyder & Son. Inc., M. L., 1811 E. York St., Philadelphia 25, Pa.
Socony Mobil Oil Co., 26 Broadway, New York 4, N. Y.
Soiltest. Inc., 4711 W. North Ave., Chicago 39, Illinois.
Solar Aircraft Co., 220 Pacific Highway, San Diego, Calif.
Solvay Process Div., Allied Chemical Corp., 61 Broadway, New York 6, N. Y.
Sorel Steel Foundries. Ltd., Room 504, 1405 Peel St., Marine Bldg., Montreal 2, P. Q., Canada
Sorgel Electric Co., 838-B W. National Ave., Milwaukee 4, Wis.
Soros Paul, Thayer Pond Road, New Canaan, Conn.
South Bend Lathe Works, 419 E. Madison St., South Bend 22, Ind.
Southern Carbon Brush Co., 7—18th St., S. W., Birmingham, Ala.
Southwestern Engineering Co., 4800 Santa Fe Ave., Los Angeles 58, Calif.
Southwestern Industrial Electronics Co., P. O. Box 13058. Houston 19, Tex.
Spang & Co., 143 Etna St., Butler, Pa.
Spartan Air Services. 74 Sparks St., Ottawa Ont., Canada.
Special Instruments Laboratory, Inc., P. O. Box 2108, 312 W. Vine Ave., Knoxville. Tenn.
Specialty Engineering Co., 3300 Frankford Ave., Philadelphia 34. Pa.
Spectrochemical Laboratories, Inc., 1010 Wood St., Wilkinsburg, Pittsburgh, Pa.
Speer Carbon Co., St. Marys, Pa.
SPENCER CHEMICAL CO. Dwight Bldg., Kansas City 5, Mo. Page 187.
Spencer Turbine Co., 486 New Park Ave., Hartford 6, Conn.
Split Ballbearing, Div., MPB, 211 Mechanic, Lebanon, N. H.
SPRAGUE & HENWOOD INC., 221 West Olive St., Scranton, Pa. Opposite Page 8.
SPRAYING SYSTEMS CO., Randolph St., Bellwood, Ill. Page 212.
SPRENGNETHER INSTRUMENT CO., INC., V. F., 4567 Swan Ave., St. Louis 10, Mo. Page 160.
Springfield Boiler Co., 20th & E. Capitol Ave., Springfield, Ill.
Square D Co., 6060 Rivard St., Detroit 11, Mich.
Stackpole Carbon Co., St. Marys, Pa.
Stahl Gear & Machine Co., 3901 Hamilton Ave., Cleveland 14, Ohio.
Stamler Corp., W. R., Paris, Ky.
Stanco Manufacturing Corp., 1666 Ninth St., Santa Monica, Calif.
Standard Elec. Mfg. Co., Inc., Haddon Ave., West Berlin, N. J.
Standard Electrical Tool Co., 2490 River Rd., Cincinnati 4, Ohio.
Standard Metal Mfg. Co., Malinta, Ohio.
STANDARD OIL CO., OF CALIFORNIA. WESTERN OPERATIONS, INC., 225 Bush St., San Francisco 20, Calif. Page 155.
Standard Oil Co —Indiana, 910 S. Michigan Ave., Chicago 5, Ill.
Standard Steel Corp., 5060 Boyle Ave., Los Angeles 58, Calif.
Standard Transformer Co., Warren, Ohio.
Stanley Co., Inc., William W., 401 Broadway, New York 13, N. Y.
Stanley Electric Tools, Div., Stanley Works, New Britain, Conn.
Staplex Co., Air Sampler Div., 777 Fifth Ave., Brooklyn 32, N.Y.
Star Brass Works, 1501 Fulford St., Kalamazoo 24F, Mich.
Star Expansion, Pleasant Hill Rd., Mountainville, N. Y.
Star Jack Co., 420 Lexington Ave., New York 17, N. Y.
Star Wire Screen & Iron Works, Inc., 2515 San Fernando Road, Los Angeles 65, Calif.
STARDRILL-KEYSTONE CO., 920—17th St., Beaver Falls, Pa., Page 200.
STEARNS MAGNETIC PRODUCTS, 635 S. 28th St., Milwaukee 46, Wis. Page 201.
STEARNS ROGER MFG. CO., 660 Bannock St.—P. O. Box 5370, Denver 17, Colo. Page 169.
Steber Mfg. Co., 2700 Roosevelt Rd., Broadview, Ill.
Steel-Bilt Construction Co., Carol Ave., Bridgeville, Pa.
Steel City Electric Co., 1207 Columbus Ave., Pittsburgh 33, Pa.
Steelcraft Mfg. Co., 9017 Blue Ash Rd., Cincinnati 42, Ohio.
Steelduct Co., Republic Bldg., Youngstown 3, Ohio.
Stein, Hall & Co., Inc., 285 Madison Ave., New York, N. Y.
Stephens-Adamson Mfg. Co., 4 Ridgeway Ave., Aurora, Ill.
Sterling Electric Motors, Inc., 5401 Telegraph Rd., Los Angeles 22, Calif.
Sterling Grinding Wheel Co., Tiffin, Ohio.
Sterling Steel Casting Co., P. O. Box 230. East St. Louis, Ill.
Stewart-Warner Corp., Alemite Div., 1826 Diversey Parkway, Chicago 14, Ill.
Stimmel Winch Co., Inc., 37-24 33 St., Long Island City, N. Y.
Stockham Valves & Fittings, Birmingham, Ala.
Stokes Corp., 5500 Tabor Road, Philadelphia 20, Pennsylvania.
Stone & Webster Engineering Co., 90 Broad St., New York, N. Y.
Stoody Co., P. O. Box 901, Whittier, Calif.
Stop-Fire, Inc., U. S. Highway 1 at Blackhorse Lane, New Brunswick, N.J.
Stowell & Co., W. H., W. 421 Sprague Ave., Spokane 4, Wash.
Stratex Instrument Co., 3515 Sunset Blvd., Los Angeles 26, Calif.
Stratoflex, Inc., P. O. Box 10398, Fort Worth, Tex.
Straub Mfg. Co., 8381 Baldwin St., Oakland 21, Calif.
Streeter-Amet Co., Graystake, Ill.
Stroh Process Steel Co., 1428 High St., Pittsburgh 12, Pa.
Strong, Carlisle & Hammond Co., 1392 W. 3rd St., Cleveland 13, Ohio.
Strong Steel Foundry Co., Hertel & Norris Ave., Buffalo 7, N. Y.
Stulz-Sickles Co., 929-939 Julia St., Elizabeth, N. J.
Sturtevant Mill Co., 101 Clayton St., Boston 22, Mass.
Sun Oil Co., 1608 Walnut St., Philadelphia 3, Pa.
SUN SHIPBUILDING & DRYDOCK CO., Chester, Pa. Page 127.
Sutphen, Peter O., Box 58, Everett, Pa.
Superior-Lidgerwood-Mundy Corp., 1101 John Ave., Superior, Wis.
Sutton Steele & Steele, Inc., 1031 South Haskell St., Dallas 23, Tex.
Siverkrop Instruments, P. O. Box 436, Bakersfield, Calif.
Swaby Mfg. Co., 3818 W. Armitage Ave., Chicago 47, Ill.
Swan-Finch Oil Corp., 338 Hudson St., Hackensack, N. J.
Sweet's Steel Co., 770 Sweet St., Williamsport, Pa.
Sweco Tube Corp., One Clifton Blvd., Clifton, N. J.
Swett Iron Works, A. L., 158 Glenwood Ave., Medina, N. Y.
Sylvania Electric Products. Inc., Chemical & Metallurgical Div., Towanda, Pa.
Synthane Corp., River Rd., Oaks, Pa.
Syntron Co., 510 Lexington, Homer City, Pa.

T

Talcott, Inc., 81 Sabin St., Providence, R. I.
Talk-A-Phone Co., 1512 South Pulaski Rd., Chicago 23, Ill.
Taller & Cooper Inc., 75 Front St., Brooklyn, N. Y.
Taylor Chain Co. Inc., S. G., 141 St. & Ind. Harbor Belt Tracks Hammond, Ind.
Taylor Fibre Co., Norristown, Pa.
Taylor & Co., W. A., 7300 York Rd., Baltimore 4, Md.
Taylor-Wharton Co. Div., Harsco Corp., High Bridge, N. J.
Telluride Iron Works Co., 400 Main

Ave., Durango, Colo.
Templeton, Kenly & Co., 16th & Gardner Rd., Broadview, Ill.
Tennant Sons & Co., C. OF N. Y., 100 Park Ave., New York 17, N. Y.
Tennant Sons & Co., C. OF N. Y., Sink & Float Div., 100 Park Ave., New York 17, N. Y.
Tennessee Coal & Iron Div., U. S. Steel Corp., P. O. Box 599, Fairfield, Ala.
Terry Steam Turbine Co., 874 Windsor St., Hartford, Conn.
TEXAS CO., 135 E. 42nd St., New York 17, N. Y. Pages 4-5.
Texas Gulf Sulphur Co., 75 East 45, New York, N. Y.
Texas Instruments, Inc., Industrial Instrumentation Div., 3609 Buffalo Speedway, Houston, Tex.
Thermoid Co., Industrial Div., Whitehead Rd., Trenton 6, N. J.
Thew Shovel Co., Lorain, Ohio.
Thickol Chemical Corp., 780 North Clinton Ave., Trenton 7, N. Y.
Thomas & Betts Co., 36 Butler St., Elizabeth 1, N. J.
Thomas Flexible Coupling Co., Warren, Pa.
Thomas Foundries, Inc., P.O. Box 1111, Birmingham 1, Ala.
Thompson Products, Ltd., St. Catherines, Ont., Canada.
Thor Power Tool Co., Prudential Plaza, Chicago 1, Ill.
Throwaway Bit Corp., 4200 N. W. Yeon Ave., Portland 10, Ore.
Thurman Machine Co., 156 N. 5th St., Columbus, Ohio.
Timken Roller Bearing Co., 1835 Dueber Ave., S. W., Canton 6, Ohio.
Tipp Mfg. Co., Tipp City, Ohio.
Titan Metal Mfg. Co., Bellefonte, Pa.
Titeflex, Inc., Hendee St., Springfield 4, Mass.
Toledo Pipe Threading Machine Co., 1445 Summit Ave., Toledo 4, Ohio.
Toledo Scale Co., 1002 Telegraph Rd., Toledo 1, Ohio.
Tool Steel Gear & Pinion Co., 211 Township Ave., Cincinnati 16, Ohio.
Torrington Co., 59 Field St., Torrington, Conn.
Torrington Co., Bantam Bearings Div., 3702 West Sample St., South Bend 21, Ind.
Torsion Balance Co., Clifton, N. J.
Tour & Co., Sam 44 Trinity Pl., New York 6, N. Y.
Tracerlab, Inc., 1601 Trapelo Rd., Waltham 54, Mass.
TRACTOMOTIVE CORP., County Line Rd., Deerfield, Ill. Page 157.
Transport Trailers, Inc., 1230—12th St. S. W., Cedar Rapids, Iowa.
Trans-Weigh Corp., Wayne, Pa.
TRAYLOR ENGINEERING & MFG. CO., Allentown, Pa., Pages 138-139.
TREADWELL CO., M. H., 140 Cedar St., New York 6, N. Y. Pages 132-133.
Triangle Conduit & Cable Co., Inc., Triangle & Jersey Aves., New Brunswick, N. J.
Trico Fuse Mfg. Co., 2948 N. 5th St., Milwaukee 12, Wis.
Trojan Powder Co., 17 N. 7th St., Allentown, Pa.
Trombetta Solenoid Corp., 329 N. Milwaukee St., Milwaukee 2, Wis.
Troy Engine & Machine Co., 3 Railroad Ave., Troy, Pa.
Truck Engineering Corp., 1285 W. 70th St., Cleveland 2, Ohio.
Tube Turns Div., National Cylinder Gas Co., 224 East Broadway, Louisville 1, Ky.
Turbo-Mixer Div., General American Transportation Corp., 380 Madison Ave., New York 17, N. Y.
Turner Halsey Co., 40 Worth St., New York 13, N. Y.
Tweco Products, Inc., Boston at Mosley, Wichita 1, Kan.
Twin City Iron Works, Hurley, Wis.
Twin Disc Clutch Co., Racine, Wis.
Tyler Co., W. S., 3615 Superior Ave., Cleveland 14, Ohio.
Tyson Bearing Corp., Subsidiary of SKF Industries, Inc., Massillon, Ohio.

U

Uehling Instrument Co., 473 Getty Ave., Paterson 3, N. J.
Uhrden, Inc., Dennison, Ohio.
Ultra-Violet Products, Inc., 5114 Walnut Grove Ave., San Gabriel, Calif.
Union Asbestos & Rubber Co., 1111 West Perry St., Bloomington, Ill.
Union Carbide Chemicals Co., Union Carbide Corp., 30 East 42 St., New York 17, N.Y.
Union Chain & Mfg. Co., Sandusky, Ohio.
Union Oil Co., 45 Rockefeller Plaza, New York, N. Y.
Union Switch & Signal, Div. of Westinghouse Air Brake Co., Swissvale, Pa.
Union Wire Rope Corp., Sub. of Armco Steel Cor., 2100 Manchester Ave., Kansas City 26, Mo.
Unit Crane & Shovel Corp., 6411 W. Burnham St., Milwaukee 19, Wis.
U. S. Electrical Motors, Inc., 200 E. Slauson Ave., Los Angeles 54, Calif.
U. S. Electrical Tool Co., 3640 Llewellyn St., Cincinnati 22, Ohio.
U. S. Gauge Div., American Machine & Metals, Inc., Sellersville, Pa.
U. S. Hoffman Machinery Corp., Air Appliance Div., 103 4th Ave., New York 3, N. Y.
U. S. Pipe & Foundry Co., 3300 First Ave., North Birmingham 2, Ala.
U. S. Rubber Co., 1230 Sixth Ave., New York 20, N. Y.
U. S. Rubber Co., Mechanical Goods Div., 1230 Ave. of the Americas, New York 20, N. Y.
U. S. Safety Service Co., 1535 Walnut St., Kansas City 8, Mo.
U. S. Smelting Furnace Co., East A St. & L & N Tracks, Belleville, Ill.
U. S. Smelting, Refining & Mining Co., Inc., 57 Williams St., New York, N. Y.
U. S. STEEL CORP., COLUMBIA-GENEVA STEEL DIV., 120 Montgomery St., San Francisco 6, Calif. Page 135.
U. S. STEEL CORP., NATIONAL TUBE DIV., 525 Wm. Penn Place, Pittsburgh 30, Pa. Page 135.
U. S. Testing Co., Inc., 1415 Park Ave., Hoboken, N. J.
Universal Atomics Div., Universal Transistor Products Corp., 143 E. 49th St., New York 17, N. Y.
Universal Dredge Mfg. Co., 124 Wazee Market, Denver 4, Colo.
Universal Electric Sales Corp., 2557 E. 79th St., Cleveland 4, Ohio
Universal Engineering Corp., 625 C Ave. N. W., Cedar Rapids, Iowa.
Universal Motor Co., 422 Universal Dr., Oshkosh, Wis.
Universal Road Machinery Co., Kingston, N. Y.
Universal Vibrating Screen Co., Deane Blvd. & St. Paul RR, Racine, Wis.
Utah Construction Co., Shell Bldg., San Francisco, Calif.
Utility Mine Equipment Co., 1010 Collingwood Rd., St. Louis 24, Mo.

V

V. V. Fittings Co., 715 Cherry St., Philadelphia, Pa.
Vale Do Rio Doce Trading Co., Inc., 63 Wall St., New York 5, N. Y.
Valve Div., Thompson Products, Inc., 1455 East 185 St., Cleveland 10, Ohio.
Valvoline Oil Co., Div., Ashland Oil & Refining Co., 639 Third Ave., Freedom, Pa.
Van Gorp Mfg., Inc., Box 123, Pella, Iowa
Van Waters & Rogers, Inc., 4000—1st St., Seattle 4, Wash.
Vanadium-Alloys Steel Co., Latrobe, Pa.
Vapor Recovery Systems Co., 2820 N. Alameda St., Compton, Calif.
Varel Mfg. Co., Box 13146, Dallas, Texas.
Varlen Associates, 611 Hansen Way, Palo Alto, Calif.
VASCOLOY-RAMET CORP., 800 Market St., Waukegan, Ill. Page 152.
The Viber Co., 726 S. Flower, Burbank, Calif.
Vickers Inc., Administrative & Engineering Center, Detroit 32, Mich.
VICTAULIC CO. OF AMERICA, Box 509, Elizabeth, N. J. Page 156.
VICTOR EQUIPMENT CO., ALLOY ROD & METAL DIV., 13808 East Imperial Highway, Norwalk, Calif. Page 195.
Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.
Visking Co., Plastics Div., P. O. Box 1410, Terre Haute, Ind.
Vitro Corp. of America, 261 Madison Ave., New York, N. Y.
Voland & Sons, Inc., P. O. Box 680, New Rochelle, N. Y.
Vulcan Electric Co., 88 Holten St., Danvers, Mass.
VULCAN IRON WORKS CO., (DENVER), 2960 S. Fox, Englewood, Colo. Page 177.
Vulcan Iron Works, 730 S. Main St., Wilkes-Barre, Pa.

W

Wadsworth Electric Mfg. Co., 20 W. 11th St., Covington, Ky.
Wagner Electric Corp., 6401 Plymouth Ave., St. Louis, Mo.
Wah Chang Corp., 233 Broadway, New York 7, N. Y.
Waldron Corp., John, River Rd., New Brunswick, N. J.
Walker Brothers, Spring Mill Rd., Conshohocken, Pa.
Walter Motor Truck Co., 1001 Irving Ave., Ridgewood 27, Queens, Long Island, N. Y.
Walker & Wiryle, Inc., 409 Pearl St., New York 7, N. Y.
Wall Colmonoy Corp., 19345 John R. St., Detroit 3, Mich.
Wallace & Tiernan Inc., Belleville 9, N. J.
Waltham Grinding Wheel Co., Waltham 54, Mass.
Walwood, Inc., O. W., 300 Detroit St., Denver 6, Colo.
Walworth Co., 750 Third Ave., New York 17, N. Y.
WARN MFG. CO., Box 6064 Riverton Branch, Seattle 88, Wash. Page 204.
Warren-Knight Co., 136 N. 12th St., Philadelphia 7, Pa.
Warren Pumps, Inc., Warren, Mass.
Warsop Power Tools Ltd., 42 Northline Rd., Toronto 16, Ont., Canada.
Washington Iron Works, 1520—6th Ave. S., Seattle 4, Wash.
Washington Machinery Co., 7329 E. Marginal Way, Seattle 8, Wash.
Watt Car & Wheel Co., Barnesville, Ohio.
Waukesha Motor Co., Waukesha, Wis.
Weatherhead Co., Fort Wayne Div., 128 W. Washington Blvd., Fort Wayne, Ind.
Webb Belting & Supply Co., 1501-07 W. 12th St., Kansas City 1, Mo.
Webb Co., Jervis B., 8957 Alpine Ave., Detroit 4, Mich.
Webb Corp., Box 549, Webb City, Mo.
Webster Mfg., Inc., Tiffin, Ohio.
Wedge Wire Corp., Gas St. & N. P. R. R., Wellington, Ohio.
Weinman Pump Mfg. Co., 270 Spruce St, Columbus 8, Ohio
Wellington Sears Co, 65 Worth St, New York, N. Y.
Wellman Co., S. K. 200 Egbert Rd, Bedford, Ohio.
Wellman Engineering Co., McDowell Enterprise, 7000 Central Ave., Cleveland 4, Ohio.
West End Chemical Co., 608 Latham Square Bldg., Oakland, Calif.
West Virginia Armature Co., Pine St., Bluefield, W. Va.
West Virginia Belt Repairs, Inc., P.O. Box 361, Mt. Hope, W. Va.
West Virginia Pulp & Paper Co., 230 Park Ave., New York 17, N. Y.
West Virginia Works, Connors Steel Div., H. K. Porter Co., Inc. (Delaware), P. O. Box 118, Huntington 6, W. Va.
Western Block Co., 247 Market St., Lockport, N. Y.
Western Gear Corp., 2600 E. Imperial Highway, P. O. Box 182, Lynwood, Calif.
Western Insulated Wire Co., 2425 E. 30th St., Los Angeles, Calif.
WESTERN MACHINERY CO., 650 Fifth St., San Francisco 7, Calif. Page 11.
Western Precipitation Corp., 1016 W. 9th St., Los Angeles 15, Calif.
Western Radiation Laboratory, 1107 W. 24th St., Los Angeles 7, Calif.
WESTERN ROCK BIT MFG. CO., 552 W. 7th South St., Salt Lake City 4, Utah. Page 168.
Westfalia Lunen, c/o Mining Progress, Inc., Highland Mills, N. Y.
Westinghouse Air Brake Co., 3 Gateway Center, Pittsburgh 22, Pa.
Westinghouse Air Brake Co., Ind. Products Div., Wilmerding, Pa.
Westinghouse Electric Corp., Box 868, Pittsburgh 30, Pa.
Westinghouse Electric Corp., Sturtevant Div., Hyde Park, Boston 36, Mass.
Weston Instruments Div. of Daystrom, Inc., 614 Frelinghuysen Ave., Newark 12, N.J.
Wheel Trueing Tool Co., 3200 W. Davison Ave., Detroit 38, Mich.
Wheelabrator Corp., 1202 S. Byrkit St., Mishawaka, Ind.
Wheelco Instr. Div, Barber-Colman Co, 1300 Rock St., Rockford, Ill.
Wheeler Co., Inc., 2408 Harrison St., Topeka, Kansas.
Wheeler Electronic Corp., Subsidiary Sperry Rand Corp., Waterbury, Conn.
Wheeler Mfg. Co. C. H. Lehigh & Sedgley Aves., Philadelphia 32, Pa.
Wheeling Steel Corp., 1134-1140 Market St., Wheeling, W. Va.
WHITE DIESEL ENGINE DIV., WHITE MOTOR CO., 1401 Sheridan Ave., Springfield, Ohio. Page 150.
White Instrument Co., David., 2051 N. 19th St., Milwaukee 5, Wis.
White Lamb Finaly, Inc., 204 Chancellor St., Philadelphia 6, Pa.
Whites Electronics, 1218 M Street, Sweet Home, Ore.
Whiting Corp., 157th St., Harvey, Ill.
Whitmore Mfg. Co., P. O. Box 1640, Station C, Cleveland 4, Ohio
Whitney Chain Co, 237 Hamilton St, Hartford 2, Conn.
Wickwire Spencer Steel Div., Colorado Fuel & Iron Corp., 575 Madison Ave., New York 22, N. Y.
Wild Heerbrugg Instruments, Inc., Main & Covert Sts., Port Washington, N. Y.
Wiley Mfg. Co., Port Deposit, Md.
Wilbur & Williams Co., 130 Lincoln St., Brighton, Boston 35, Mass.
Wilcox Mfg. Co., P. O. Box 217, Raleigh, W. Va.
WILFLEY & SONS, A. R., Denham Bldg., P. O. Box 2330, Denver 2, Colo. Page 216.
Wilkerson Corp., 1601 West Girard Ave., Englewood, Colo.
Willey's Carbide Tool Co., 1340 West Vernon Highway, Detroit, Mich.
Williams & Son, E. A., 325 Washington Ave., Carlstadt, N. J.
Williams, I. B. & Sons, 51 Washington St., Dover, N. H.
Williams Patent Crusher & Pulverizer Co., 810 Montgomery St., St. Louis 6, Mo.
Willys Motors, Inc., Administration Bldg., Toledo, Ohio.
Wilson Products Div., Ray-O-Vac Co., 200 Thorn St., Reading, Pa.
Wilson Rubber Co., 1200 Garfield Ave., S. W. Canton 6, Ohio.
Wincharger Corp., Zenith Radio Corp., Sioux City, Iowa.
Windeler Co., Ltd., George, 2201 Jerrold Ave., San Francisco 24, Calif.
Wing Mfg. Co., L. J., 303 Vreeland Mills Rd., Linden, N. J.
Winslow Engineering & Mfg. Co., 4069-73 Hollis St., P. O. Box 8246, Oakland 8, Calif.
Winston Bros. Co., 301 Clifton Ave., Minneapolis 3, Minn.
WINTER WEISS CO., 2201 Blake St., Denver 5, Colo. Page 190.
Wintroath Pumps Div., Worthington Corp., 1100 S. Meridian Ave., Alhambra, Calif.
Wire Rope Corp. of America, Inc., 609 N. 2nd St., St. Joseph, Mo.
Wisconsin Motor Corp., Milwaukee 46, Wis.
Witte Engine Works, Oil Well Supply Div., U. S. Steel Corp., 1600 Oakland Ave., Kansas City 26, Mo.
Wodack Electric Tool Corp., 4627 W. Huron St., Chicago 44, Ill.
Wolf Safety Lamp Co. of America, Inc., 227 Grand Ave., Brooklyn 5, N. Y.
Wood Assaying Co., Henry E., 733 West Colfax, Denver 4, Colo.
Wood Shovel & Tool Co., Roosevelt & Clark Ave., Piqua, Ohio.
Wood Steel Co., Alan, Conshohocken, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.
Worthington Corp., Worthington Ave., Harrison, N. J.
Wright Power Saw & Tool Corp., Subsidiary of Thomas Industries, 1419 Illinois Ave., Sheboygan, Wis.
Wyandotte Chemicals Corp., Michigan Alkali Div., Wyandotte, Mich.

Y

Yale & Towne Mfg. Co., Yale Materials Handling Div., 11000 Roosevelt Blvd., Philadelphia 15, Pa.
Yara Engineering Corp., Interstate Equipment Div., 18 W. Jersey St. Elizabeth 4, N. J.
Yardney Electric Corp, 40-46 Leonard St., New York 13, N. Y.
Yarnall-Waring Co., 102 E. Mermaid Lane, Chestnut Hill, Philadelphia 18, Pa.
Yaun Mfg. Co., Inc., 2120 North Third St., P. O. Box 1508, Baton Rouge, La.
Youngstown Sheet & Tube Co., Stambaugh Bldg., Youngstown 1, Ohio.
Yuba Consolidated Industries, Inc., 351 California St., San Francisco 4, Calif.

Z

Zephar Mills, Inc., 118-26th St., Brooklyn 32, N. Y.
Zurn Mfg., J. A., Div., Zurn Industries Inc., 1955 Pittsburgh Ave., Erie, Pa.

3. Guidebook Advertisers' District Sales Offices

Listed Geographically for Easy Reference

This listing of sales offices is designed to help Guidebook users quickly locate their nearest source of supply for manufacturers advertising in this issue. A company name in black-faced type in the Product Classification Section (page 217) notes that more information on products offered by that manufacturer is available in advertisements on pages listed in the Manufacturers Index or in the Advertisers' Index on page 262.

A

Aero Service Corp., 210 E. Courtland St., Philadelphia 20, Pa.
California, San Francisco: 68 Post St., Room 420
Minnesota, Duluth: 500 Christie Bldg., 120 North Fourth Ave.
Oklahoma, Tulsa: 1401 S. Detroit St.
Utah, Salt Lake City: 33 Richards St.
Wisconsin, La Crosse: 307 State Bank Bldg.
Canada, Ottawa, Ontario: 348 Queen St.
Canada, Toronto, Ontario: 347 Bay St.
England, London: 20 Albert Embankment

Wm. Ainsworth & Sons, Inc., 2151 Lawrence St., Denver 5, Colo.

Allen-Sherman-Hoff Pump Co., 259 East Lancaster Ave., Wynnewood, Pa.
Illinois, Chicago 5: 407 Dearborn St.
New York, New York 16: 271 Madison Ave.

American Brattice Cloth, Warsaw, Ind.

American Cyanamid Co., Mining Chemicals Dept., 30 Rockefeller Plaza, New York 20, N. Y.
California, Oakland: 1440 Broadway
Texas, El Paso: c/o Bailey Warehouse Co., 450 Canal St.
Washington, Spokane: c/o Goodwin - Mayflower Warehouse, 155 S. Stevens St.

American Mine Door Co., 2039 Dueber Ave., S. W., Canton 6, Ohio.

American Smelting & Refining Co., 120 Broadway, New York 5, N. Y.

Anaconda Wire and Cable Co., 25 Broadway, New York 4, N. Y.
California, Los Angeles 17: 807 Douglas Oil Bldg.
California, San Francisco 4: Room 2375, 120 Montgomery St.
Colorado, Denver 2: Room 706, Railway Exchange Bldg., 909 Seventeenth St.
Illinois, Chicago 6: 20 North Wacker Dr.
Louisiana, New Orleans 12: 601 Hibernia Bank Bldg.
Massachusetts, Cambridge 42: Kendall Square Bldg., 238 Main St.
Michigan, Detroit 2: 621 New Center Bldg.
Minnesota, Minneapolis 2: Room 1715 Foshay Tower, 821 Marquette Ave.
Missouri, St. Louis 8: 400-401 Continental Bldg., 3615 Olive St.
New York, New York 6: Room 2611-12, 21 West St.
North Carolina, Charlotte 2: 213 Wilder Bldg.
Pennsylvania, Philadelphia 3: Room 1016, 1616 Walnut St. Bldg.
Pennsylvania, Pittsburgh 22: 1526 Bldg. No. 3, Gateway Center
Texas, Dallas 1: 1201 Fidelity Union Life Bldg., 1511 Bryan St.
Washington, Seattle 1: 954 Stuart Bldg., Metropolitan Center
West Virginia, Charleston 1: 501, 503, 505 Peoples' Bldg.
Wisconsin, Milwaukee 3: Room 368 Bockl Bldg., 2040 West Wisconsin

Asea Electric, Inc., 500 Fifth Ave., New York 36, N. Y.

Associated Metals & Minerals Corp., 75 West St., New York 6, N. Y.
California, San Francisco: 593 Market

Austin - Western, Construction Equipment Div., Baldwin-Lima-Hamilton Corp., Aurora, Ill.

B

Babcock & Wilcox Co., 161 East 42nd St., New York 17, N. Y.

Bin-Dicator Co., 13946 Kercheval St., Detroit 15, Mich.

Boyles Bros. Drilling Co. (Utah), 1321 South Main St., Salt Lake City, Utah
Arizona, Phoenix: 1016 Minnezona Ave.
Colorado, Denver: 2960 West 7th Ave.
Nevada, Reno: 970 Melrose Drive
Washington, Spokane: 11403 East 12th Ave.

Boyles Bros. Drilling Co., Ltd., 1291 Parker St., Vancouver, B.C.

Brunner & Lay, Inc., 9300 King St., Franklin Park, Ill.
Alabama, Birmingham: 5 18th St., S. W.
California, Los Angeles: 2425 E. 37th St.
California, Sacramento: 7500 14th Ave.
Colorado, Denver: 2 Santa Fe Dr.
New Mexico, Albuquerque: 2224 Broadway S. E.
North Carolina, Asheville: Sweeten Creek Rd.
Oregon, Portland: 660 N. Tillamook St.
Pennsylvania, Philadelphia: 2514 E. Cumberland St.
Texas, Dallas: 150 Leslie St.
Washington, Seattle: 2600 1st Ave. & Vine
Canada, Montreal, Quebec: 6301 Cote de Liesse POB 68 Durval St.

Buell Engineering Co., 70 Pine St., New York 5, N. Y.

Burtonite Company, 166 Chestnut St., Nutley 10, New Jersey

C

Card Iron Works, C. S., 2501 West 16th Ave., Denver 4, Colo.

Carpco Manufacturing Inc., 4120 Haines Street, Jacksonville 6, Fla.
Australia, Brisbane, Queensland: 22-24 Thurlow St., Newmarket, NW. 1
China, Hong Kong: Box 690

Cheatham Electric Switching Device Co., 4780 Crittenden Drive, Louisville 9, Ky.

Christensen Diamond Products, Co., 1937 South 2nd West, Salt Lake City, Utah

Coates Steel Products Co., P. O. Box 185, Greenville, Ill.

The Colorado Fuel and Iron Corp., Continental Oil Building, Denver 2, Colo.
Arizona, Phoenix: 305 E. Buchanan St., P.O. Box 3767
California, Los Angeles 22: 2444 S. Saybrook Ave.
California, Oakland 6: 1080 19th Ave., P.O. Box 270
California, San Francisco 3: 357-58 Russ Bldg., 235 Montgomery St.
California, San Leandro: 425 Hester St.
Colorado, Pueblo: P.O. Box 316
Idaho, Boise: P.O. Box 1552
Illinois, Chicago 32: 3838 W. 51st St.
Georgia, Atlanta: 934 Avon Ave., S.W.
Kansas, Wichita 5: 811 E. 10th St.
Louisiana, New Orleans 18: 7930 Palm St., P.O. Box 13012
Massachusetts, Boston 10: 80 Federal St.
Michigan, Detroit 26: 1915 Nat'l Bank Bldg.
Montana, Billings: 501 N. 27th St., P.O. Box 1763
Montana, Butte: 401-402 Metals Bank Bldg.
Nebraska, Lincoln 8: 404-405 Sharp Bldg.
New Mexico, Albuquerque: 2824 Central Ave.
New York, Buffalo 2: 361 Delaware Ave.
New York, New York 22: 575 Madison Ave.
Oklahoma, Oklahoma City 2: 916 Colcord Bldg.
Oregon, Portland 10: 3150 N.W. 31st Ave.
Pennsylvania, Philadelphia 40: 225 W. Erie Ave.
Texas, Amarillo: 1008 Fisk Bldg., P.O. Box 2371
Texas, El Paso: 803-5 Basset Tower Bldg., P.O. Box 2006
Texas, Ft. Worth 2: 390 Rowan Bldg., 6000 Camp Bowie Blvd., P.O. Box 12246
Texas, Houston 11: 6609 Supply Row, P.O. Box 9367
Utah, Salt Lake City 4: 212 W. 13th S. St., P.O. Box 1738
Washington, Seattle 4: 3434-44 2nd. Ave. S.

Washington, Spokane 6, 4320 E. Trent Ave.

Connellsville Manufacturing and Mine Supply Co., S. Fourth St., P. O. Box 677, Connellsville, Pa.

Coppus Engineering Corp., Worcester 10, Mass.

Crucible Steel Co. of America, Henry W. Oliver Bldg., Mellon Square, Pittsburgh 22, Pa.
California, Los Angeles 22: 6033 E. Bandini Blvd.
California, San Francisco 10: 2050 Bryant St.
Colorado, Denver 17: 63rd Ave. & Colorado Blvd., P. O. Box 5084
Georgia, Atlanta: 3400 Malone Dr., Chamblee
Illinois, Chicago 39: 4501-4531 W. Cortland St.
Massachusetts, Boston 54: Waltham Industrial Center, 45 1st Ave., Waltham, Mass.
Michigan, Detroit 34: 4920 E. Nevada
Missouri, St. Louis 14: 8610 Page Blvd.
Minnesota, St. Paul 4: 1353 Laurel Ave.
New Jersey, Harrison: P. O. Box 28, 1000 S. Fourth St.
Oregon, Portland 10: 2330 N. W. Raleigh St.
Pennsylvania, Philadelphia: 408 S. Oak Lane, Primos
Pennsylvania, Pittsburgh 30: P. O. Box 2309
Utah, Salt Lake City: 753 W. 8th St., S., P. O. Box 1694
Washington, Seattle 4: 2755 First Ave. South
Wisconsin, Milwaukee 9: P. O. Box 7, Station "F" 4200 West Douglas Rd.
Canada, Toronto 5, Ontario: 410 Bloor St., East

D

Denver Equipment Company, 1400 17th St., Denver 17, Colo.
New York, New York: 4114 Empire State Bldg.
Canada, Vancouver, B. C.: Credit Foncier Bldg.
England, London, E. C. 2: 15/17 Christopher St.
Mexico, Mexico City: Avenida Juarez 14
Peru, Lima: Orrantia 1570 San Isidro
Union of So. Africa, Johannesburg: Broadway and 9th, Bez Valley

Diamond Drill Contracting Co. Station B—Box 4065, South 18 Stone St., Spokane 31, Wash.

Diamond Tool Research Co., Inc., 380 Second Ave., New York 10, N. Y.
California, Los Angeles: 220 West 5th St., Western Div.

Diesel Energy Corp., 82 Beaver St., New York, N. Y.

Ducon Company, 147 E. 2nd St., Mineola, L. I., N. Y.
Canada, Burlington, Ontario: 1131 Pettit St.

E

Eimco Corp., 634 South 4th West, Salt Lake City 10, Utah
Alabama Birmingham: 3140 Fayette
Calif., Berkeley: 637 Cedar St.
Calif., San Mateo: 420 Peninsular Ave.
Illinois, Palatine: 301 So. Hicks Rd.
Minnesota, Duluth 5: 1823 E. Superior
New York, New York 5: 51-52 South St.
Pa., Pittsburgh 28: 666 Washington Rd.
Texas, El Paso: Mills Bldg.

Electric Storage Battery Co., Exide Industrial Div., 42 S. 15th St., Philadelphia 2, Pa.

Elektrokemisk A. S., 101 Park Ave., New York, N. Y.

Ensign-Bickford Co., 24 S. Hopmeadow St., Simsbury, Conn.

Equipment Engineers, Inc., 41 Sutter St., San Francisco 4, Calif.

F

Falk Corp., 3049 W. Canal St., Milwaukee 1, Wis.
Alabama, Birmingham 3: Rm. 649, Brown-Marx Bldg.
California, Los Angeles 22: 1068 S. Vail Ave.
California, San Francisco 7: 427 Bryant St.
Colorado, Denver 3: 655 Broadway Bldg.
Illinois, Chicago 3: 105 W. Adams St.
Illinois, Peoria: 800 S. Adams St.
Minnesota, Minneapolis 4, 807 Thirteenth Ave. South
Missouri, St. Louis 5: 8029 Forsythe Blvd.
New York, New York 7: 50 Church St.
Ohio, Cleveland 15: 2036 E. 22nd St., Rm. 215
Pennsylvania, Pittsburgh 19: 308 Grant Bldg.
West Virginia, Charleston 2: 3145 Washington St. W.
West Virginia, Fairmont: 801 Coleman Ave.
Wisconsin, Milwaukee 1: 3001 West Canal St.

G

Gardner-Denver Corp., Quincy, Ill.
California, Los Angeles 22: 7654 E. Slauson Ave.
California, San Francisco 7: 811 Folsom St.
Colorado, Denver 1: 1727 E. 39th Ave., P. O. Box 1020
Idaho, Wallace: 407 Seventh St. P. O. Box 788
Louisiana, New Orleans 25: 7735 Edinburgh St., P. O. Box 13155
Minnesota, Duluth 2: 521 East Superior
Missouri, Kansas City 14: 309 W. 79 Terrace
Montana, Butte: 215 E. Park St.
New York, Buffalo 26: 4532 Bailey Ave.
New York, New York 7: 233 Broadway, Woolworth Bldg.
Ohio, Cleveland 11: 3088 W. 117th St.
Pennsylvania, Hazelton: P.O. Box 17
Pennsylvania, Philadelphia 40: 4309-11 Rising Sun Ave.
Pennsylvania, Pittsburgh 26: 520 McNeilly Rd.
Texas, El Paso: 1704 Paisano Drive
Texas, Dallas 35: 7125 Harry Hines Blvd., P. O. Box 35106
Utah, Salt Lake City: 113 W. Second South St.
Washington, Seattle 4: 615 Eighth Ave. South
Australia, Artarmon, N. S. W.: 70 Hotham Parade
Canada, Edmonton, Alberta: 14415-114
Canada, Moncton, New Brunswick: E. Main St., P. O. Box 475.
Canada, Montreal 28; Quebec: 5825 St. James St., W.
Canada, Nelson, B. C.: 745 Baker St.
Canada, Toronto 16, Ontario: 14 Curity Ave.
Canada, Vancouver 9, B. C.: 1775 Pine
Canada, Winnipeg 3, Manitoba: 1400 Sargent Ave.
Northern Rhodesia, Ndola: P. O. Box 18, Alacrity House, Cr. Third St. & Monterey Ave.
Mexico, Mexico City 6, D. F.: Apartado 575
South America, Lima Peru: Apartado 674
South America, Rio de Janeiro, Brazil: Avenida Churchill 94-B, Caixa Postal 4293
Union of S. Africa: Johannesburg Transvaal: P.O. Box 4807

General Chemical Div., Allied Chemical & Dye Corp., (Baker & Adamson Products) 61 Broadway, New York 6, N. Y.
Illinois, Chicago 54: Merchandise Mart (Room 430)
Louisiana, New Orleans 12: 1107 Pere Marquette Bldg.
Michigan, Detroit 17: 7501 W. Jefferson Ave.
Missouri, St. Louis 8: 3615 Olive St.
New York, New York 16: 261 Madison Ave.
New York, Syracuse 9: Milton Ave.
North Carolina, Charlotte: 503 N. College St.
Ohio, Cincinnati 2: 3616 Carew Tower
Ohio, Cleveland 15: 3121 Euclid Ave.
Pennsylvania, Philadelphia 7: 12 S. 12th St.
Pennsylvania, Pittsburgh 22: 1 Gateway Center
Texas, Houston 2: 1121 Walker Ave.

Godoy & Co., Inc., E. A., 25 Broadway, New York 4, N. Y.

B. F. Goodrich Aviation Products, 500 S. Main St., Akron 18, Ohio
California, Los Angeles 22: 5400 E. Olympic Blvd.
Dist. of Columbia, Washington: 1112 19th St., N.W.
Florida, Miami Springs: Room 243 International City Bldg., 4471 N.W. 36th St.
Georgia, Atlanta 2: 1721 De Kalb Ave., N.E. P.O. Box 4509
Illinois, Chicago 44: 4646 W. Lake St.
Kansas, Wichita 2: 301 N. Main, Northern Bldg.
New York, Hicksville, L.I.: 27 W. John St.
Ohio, Dayton 2: 803-804 Winters Bldg., Second & Main St.
Ohio, Troy: P.O. Box 511
Washington, Seattle 1: 1 Hanford St.

Gordon I. Gould & Co., 58 Sutter St., San Francisco 4, Calif.

H

Hammond Co., J. V., Spangler, Pa.

Harbison-Walker Refractories Co., 307 Fifth Ave., Pittsburgh 22, Pa.
California, San Francisco 5: 625 Market
Massachusetts, Boston 10: 10 High St.
Michigan, Detroit 35: 17601 James Couzens Highway
Missouri, St. Louis 1: 1325 Ambassador Bldg.
New York, New York 5: 68 William St.
Pennsylvania, Philadelphia 3: 981 Suburban Station Bldg.
Pennsylvania, Pittsburgh 22: 307 Fifth
Texas, Houston 25: 1319 Prudential Bldg.
Canada, Ontario, Hamilton: 105 Walnut St., South
Canada, Quebec, Montreal 2: Room 540, Canada Cement Bldg.

Hardinge Co., 240 Arch Street, York, Pa.
California, San Francisco 11: Room 720, 24 California St.
Illinois, Chicago 6: 1907 Engineering Bldg., 205 W. Wacker Dr.
Minnesota, Hibbing: P.O. Box 368
New York, New York 17: 3906 Channin Building, 122 E. 42nd St.
Utah, Salt Lake City 15: 333 W. 14th South St.
Canada, Ontario, Toronto 1: 44 Victoria St.

Harnischfeger Corp., 4400 W. National Ave., Milwaukee 46, Wis.
Alabama, Birmingham 4: 1629 Vanderbilt Road, Box 1150
Arizona, Phoenix: Room 116, 39 West Adams St.
California, Los Angeles 59: 2400 East Imperial Highway
California, San Francisco: 212 Shell Building, 100 Bush St.

Colorado, Denver: Room 810, Central Bank Bldg., 1108 15th St.
Florida, Miami 56: 12035 South Dixie Highway
Georgia, Atlanta 5: Suite 3F, Luckie Bldg., 361 East Paces Ferry Rd.
Illinois, Chicago 6, Room 1534, 110 North Wacker Dr.
Michigan, Detroit 35: 17618 West McNichols Rd.
Minnesota, Minneapolis 8: 2614 Nicollet Ave.
Missouri, Kansas City 5: Rooms 604-5, 1012 Baltimore Building
Missouri, St. Louis (in Clayton 5): Room 202, Brown Building, 101 South Meramec Ave.
New York, Buffalo 22: Room 106, 257 Elmwood Ave.
New York, New York 7: Room 730, Hudson Terminal Bldg., 30 Church St.
Ohio, Cincinnati 37: Roselawn Center Building, Reading & Section Roads
Ohio, Cleveland 14: Rooms 1201-2 Superior Bldg., 815 Superior Ave., N.E.
Pennsylvania, Philadelphia 3: 856 Suburban Office Building
Pennsylvania, Pittsburgh 22: 422-5 Farmers Bank Building
Texas, Dallas 7: 1225 North Industrial Blvd.
Washington, Seattle 4: 2909 First Ave., South
Wisconsin, Milwaukee 46: 4400 West National Ave.

Hawthorne, Inc., Herb J., 8801 N. Main & 45th St., P.O. Box 7366, Houston 8, Texas

Hercules Motors Corp., 101 11th St., Canton, Ohio

Hercules Powder Co., 900 Market St., Wilmington 99, Del.
Alabama, Birmingham 3: First National Building, 17 N. 20th St.
California, Los Angeles 5: 3460 Wilshire Blvd.
California, San Francisco 4: 120 Montgomery St.
Illinois, Chicago 4: McCormick Bldg., 332 S. Michigan Ave.
Minnesota, Duluth 2: Torrey Bldg., 314-16 W. Superior St.
Missouri, Joplin: First National Bank Bldg., 404 Main St.
New York, New York 17: 380 Madison
Pennsylvania, Pittsburgh 22: 2 Gateway Circle, 603 Stanwix St.
Utah, Salt Lake City 1: Kearns Bldg., 136 S. Main St.

Hewitt-Robins, Inc., 666 Glenbrook Rd., Stamford, Conn.
Alabama, Birmingham: 3118 3rd Ave. South
Arizona, Phoenix: 207-B Camelback Rd.
California, Los Angeles: 2604 S. Malt Ave.
California, San Francisco 5: 55 New Montgomery St.
Colorado, Denver: 660 Bennock St.
Colorado, Denver: 5075 Colorado Blvd.
Florida, Miami Beach: 961 W. 48th St.
Illinois, Chicago 6: 402 W. Randolph St.
Illinois, Chicago 24: 4401 W. Roosevelt Rd.
Indiana, Indianapolis 22: 2813 Questend S. Dr.
Kentucky, Louisville 7: 319 Foeburn Lane
Louisiana, New Orleans 14: 109 Cambridge St., Aurora Gardens
Louisiana, Shreveport: 831 Gladstone St.
Michigan, Ferndale 20: 1840 Hilton Rd.
Minnesota, Hibbing: 718 E. Howard St.
Minnesota, Minneapolis 1: 533 Metropolitan Bldg.
Missouri, Kansas City 11: 312 VFW Bldg., 406 W. 34th St.
Missouri, St. Louis 10: 4030 Chouteau Ave.
New York, New York: 370 Lexington Ave.
North Carolina, Charlotte 6: P.O. Box 5277
Ohio, Cleveland 14: 314 Superior Ave., NE
Oklahoma, Tulsa: 310 Thompson Bldg.
Oregon, Portland 14: 714 N.E. 1st Ave.
Pennsylvania, Ft. Washington: Ft. Washington Park
Pennsylvania, Pittsburgh 19: 951-952 Union Trust Bldg.
Tennessee, Memphis 17: 5111 Sea Isle
Texas, Houston 11: 2528 Oakland Ave.
Texas, Houston 11: 5711 Navigation St.
Virginia, Richmond 5: 2910 W. Clay St.
Washington, Seattle: 641 Dexter Horton Bldg.
West Virginia, Bluefield: 1417 College Ave.
West Virginia, Charleston 4: P.O. Box 4207
West Virginia, Fairmont: Upper Circle, Peacock Park

Hoffman Bros. Drilling Co., Tiona St. Extension, Punxsutawney, Pa.

Humphreys Investment Co., Enginering Div., 915 First National Bank Bldg., Denver 2, Colo.

I

Industrial Physics & Electronics Co., 470 S. 10th E. St., Salt Lake City, Utah

Ingersoll-Rand Co., 11 Broadway, New York 4, N. Y.
Alabama, Birmingham 3: 1700 Third Ave., South
California, Los Angeles 33: 1460 E. Fourth St.
California, San Francisco 7: 350 Brannan St.
Colorado, Denver 2: 1641 Blake St.
Louisiana, New Orleans 25: 960 Genois St.
Michigan, Detroit 26: Congress at First
Minnesota, Duluth 2: 327 W. Michigan
Montana, Butte: 845 S. Montana St.
New York, New York 4: 11 Broadway
New York, Buffalo 2: 117 W. Chippewa St.
Ohio, Cleveland 3: 4506 Chester Ave.
Oklahoma, Picher: 226 West A. St.
Oregon, Portland 5: Room 1004 Broadway Bldg.
Pennsylvania, Pittsburgh 22: 932 Penn
Tennessee, Knoxville 24: 412 W. Jackson Ave.
Texas, Dallas: 1728 Canton St.
Texas, El Paso: 2100 Wyoming St.
Utah, Salt Lake City 1: 144 S.W. Temple St.
Virginia, Richmond 21: 3431 W. Leigh St.
Washington, Seattle 4: 527 First Ave., South

International Bartering Co., 52 Broadway, New York 4, N. Y.
D. C., Washington: 14th and G. Sts., N.W., Colorado Bldg.

International Minerals & Metals Corp., 11 Broadway, New York 4, N.Y.

Iowa Manufacturing Co., 916 16th St., N.E., Cedar Rapids, Iowa

Isbell Construction Co., P.O. Box 2351, Reno, Nevada

K

KW-Dart Truck Co., 2623 Oak Street, Kansas City, Mo.
Iowa, Des Moines: 6503 S.W. 17th St.
New York, Long Beach: 23 Virginia
Ohio, Cleveland: Westlake Hotel
Utah, Bountiful: 944 East Center St.

Kennametal Inc., Mining Tool Div., Bedford, Pa.
Illinois, Benton: 1307 N. Main St.
Indiana, Vincennes: 224 Wilbur St.
Kentucky, Barbourville: 419 S. Main St., P.O. Box 337
Kentucky, Belfry: P.O. Box 28
Ohio, Crooksville: 303 Walnut St.
Pennsylvania, Cadogan:
Pennsylvania, Glenshaw: 107 Orchard Ave.
Pennsylvania, Latrobe: 215 Loyalhanna Ave.
Pennsylvania, Mars: P.O. Box 236
Pennsylvania, Rimersburg: P.O. Box 289
Pennsylvania, Waynesburg: Morning Side, R. D. #3
Pennsylvania, Wyoming: 41 Shulde Lane
Tennessee, Chattanooga 11: 1314 S. Seminole Dr.
Utah, Springville: 164 W. 2 So.
West Virginia, Bluefield: P.O. Box 834
West Virginia, Morgantown: P.O. Box 1133
West Virginia, Oak Hill: 368 Kelly Ave.

Kern Instruments, Inc., 120 Grand St., White Plains, N.Y.

L

Letourneau-Westinghouse, P.O. Box 240, Peoria, Ill.

Linatex Corp. of America, Stafford Springs, Conn.
Canada, Quebec, St. Laurent: 1975 Bois Franc Rd., Wilkinson Linatex, Ltd.

Link-Belt Co., Dept. EMBGL-58, Prudential Plaza, Chicago 1, Ill.
California, Los Angeles 22, P. O. Box 22056, 1200 Sycamore St., Montebello
California, San Francisco 24: 400 Paul
Colorado, Denver 2: Schloss & Shubart, 1626 Wazee St.
Illinois, Chicago 9: 301 W. Pershing Rd.
Indiana, Indianapolis: 220 S. Belmont Ave.
Kentucky, Louisville 2: 235 E. Burnett St.
Michigan, Detroit 4: 5938 Linsdale Ave.
Minnesota, Duluth 2: 301 W. First St.
Minnesota, Minneapolis 5: 200 Lyndale Ave. North
Missouri, St. Louis 1: 311 N. 11 St.
New York, N. Y. 17: 530 Fifth Ave.
North Carolina, Charlotte 2: 112 S. Tryon St.
Oregon, Portland 10: 3030 N. W. Industrial St.
Pennsylvania, Pittsburgh 13: 5020 Centre Ave.
Texas, Dallas 21: 500 Good-Latimer Expressway
Utah, Salt Lake City 1: 108 S. Fourth West St.
Washington, Seattle 4: 3405 Sixth Ave. South
Washington, Spokane 10: N. 1303 Washington St.
West Virginia, Huntington: 1009 5th Ave.
Wisconsin, Milwaukee 3: 808 N. Third
Australia, Sidney: P.O. Box 41 Marrickville
Brazil, Sao Paulo: Rua Barao de Alapetining 46.
Canada, Halifax, N.S.: Austen Bros. Ltd., 118 Hollis St.
Canada, Hamilton, Ont: 605 James St. North
Canada, Montreal 15, Que: 945 Beaumont Ave.
Canada, Scarboro (Toronto 13), Ont.: 1960 Eglinton Ave. East, Scarboro, P.O. Box 173, Station H.
Canada, Swastika: 8 Boisvert St.
Canada, Sydney, N.S.: 361 George St.
Canada, Vancouver 12, B.C.: 2550 Boundary Rd.
Canada, Winnipeg 10, Manitoba: 1315 Portage Ave.

Logan Engineering Co., 4901 West Lawrence Ave., Chicago 30, Ill.

M

Machinery Center, Inc., 1201 S. 6th West St., P.O. Box 964, Salt Lake City 1, Utah

Mack Trucks, 1355 West Front Street, Plainfield, N. J.
Alabama, Birmingham: 2820

Sixth Ave., So. (P.O. Box 1009)
California, Arcata: 50 South "G" St. (P.O. Box 457)
California, Los Angeles: 2001 S. Alameda St.
California, Palo Alto: 499 Hamilton Ave.
California, San Francisco: 1745 Folsom St.
Colorado, Denver: 4850 Vasquez Blvd.
Florida, Jacksonville: 2203 West Beaver St. (P.O. Box 2880)
Florida, Tampa: 604 So. Morgan St. (P.O Box 1404)
Georgia, Atlanta: 780 Memorial Drive, S.E.
Illinois, Chicago: 33rd St. & Wentworth Ave.
Indiana, Indianapolis: 1810 W. 16th St.
Kentucky, Louisville: 225 East Walnut St.
Louisiana, New Orleans: 1001 So. Jefferson Davis Pkway.
Michigan, Detroit: 10401 Ford Rd., Dearborn
Minnesota, St. Paul: 2505 University Ave. (Midway)
Missouri, Kansas City: 3738 Gardner Ave.
Missouri, St. Louis: Chouteau Ave. at Jefferson
New Jersey, Newark: 1239 Broad Street
New York, Albany: 1064 Broadway
New York, Buffalo: 267 Michigan Ave.
New York, Newburgh: Cochecton Turnpike
New York, Poughkeepsie: 205 Delafield St. (P.O. Box 471)
New York, Syracuse: East Erie Blvd.
North Carolina, Charlotte: 228 Dalton Ave. (P.O. Box 1967)
Ohio, Akron: 1100 Triplett Blvd. (P.O. Box 7155)
Ohio, Cincinnati: 1223 W. 8th St.
Ohio, Cleveland: 13600 Broadway
Oklahoma, Oklahoma City: 1816 N.E. 10th St.
Oregon, Eugene: 933 Franklin Blvd. (P.O. Box 709)
Oregon, Portland: 1122 N. Williams Ave.
Pennsylvania, Erie: 960 West 12th St.
Pennsylvania, Harrisburg: 2020 Paxton St.
Pennsylvania, Philadelphia: 2647 East York St.
Pennsylvania, Pittsburgh: 728 Shore Ave.
Texas, Dallas: 901 So. Akard St. (P.O. Box 1528)
Texas, Fort Worth: 2812 North Main St. (P.O. Box 4501)
Texas, Houston: 5331 Gulf Freeway (P.O. Box 18515)
Utah, Salt Lake City: 704 South Third West St.
Virginia, Richmond: 1705 Ninth Street Road
Washington, Seattle: 3703 Airport Way
West Virginia, Charleston: 5800 McCorkle Ave., S.E.
Canada, Montreal: 2150 Cote de Liesse Road
Canada, Regina, Sask: 1333 McIntyre St.
Canada, Toronto, Ont: 45 Strachan Ave.
Canada, Winnipeg, Manitoba: 301 Princess St.

Magor Car Corporation, 50 Church St., New York 7, N.Y.
California, San Francisco 11: 1045 Sansome St.

Mayo Tunnel & Mine Equipment Co., Box 1413, Lancaster, Pa.

Merrick Scale Co., 182 Autumn St., Passaic, N.J.

Mine & Smelter Supply Co., 3800 Race St., Denver 16 Colo.
New York, New York 17: 122 East 42nd St.
Texas, El Paso: 1515—11th Ave.
Utah, Salt Lake City 1: 121 W. Second South St.

Mine Safety Appliances Co., 201 North Braddock Ave., Pittsburgh 8, Pa.
Alabama, Birmingham 4: 2500 12th Ave., North
Arizona, Tucson: 1906 E. 18th St.
California, San Francisco 3: 1255 Howard St.
Colorado, Denver: 2916 Forest St.
Michigan, Ishpeming: 584 Elliott
Missouri, St. Louis 3: 1915 Washington
Montana, Billings: 4435 Jansma Ave.
Montana, Butte: 2419 Princeton Ave.
Pennsylvania, Pittsburgh 8: 201 N. Braddock Ave.
Utah, Salt Lake City 1: 257 Rio Grande
Washington, Seattle 4: 71 Columbia St.
West Virginia, Bluefield: 1513 Bluefield

Mobile Drilling Inc., 960 North Pennsylvania St., Indianapolis 4, Ind.
Alabama, Birmingham 1: 609 North Ninth St.
Arkansas, North Little Rock: 322 W. Broadway
California, Los Angeles 22: 5350 E. Washington Blvd.
Florida, Jacksonville 7: 4652 Phillips Highway
Illinois, Thornton
Iowa, Cedar Rapids: 600 D Ave., N. W.
Maryland, Baltimore 12: 6301 Blackburn Court
Minnesota, St. Paul 14: 810 Cromwell Ave.
Missouri, Kansas City 14: 304 West 79th Street Terrace
Montana, Billings: 505 North 24th St.
Montana, Great Falls: 2322 River Drive
North Carolina, Greensboro: P. O. Box 1498, So. Elm St. Extension
North Dakota, Fargo: U. S. Highway 10 West
Tennessee, Knoxville 1: Market at Front Streets
Tennessee, Memphis: 285 East Calhoun St.
Washington, Seattle 4: 3838 4th Ave., South
West Virginia, Charleston: 2855 Piedmont Rd.
Wisconsin, Milwaukee 3: 2404 W. Clybourn

Monsanto Chemical Co., Inorganic Chemicals Div., Lindbergh & Olive St. Road, St. Louis 24, Missouri
California, Los Angeles 22: 6670 East Flotilla St.
California, San Francisco 4: 111 Sutter St.
Georgia, Atlanta 9: 1401 Peachtree St., NE
Illinois, Chicago 11: McGraw Hill Bldg., 520 N. Michigan Ave.
Louisiana, Luling: Post Office Box 174
Massachusetts, Boston 49: Everett Station
Michigan, Detroit 23: 18230 Grand River Ave.
New York, New York 22: 445 Park Ave.
Ohio, Cincinnati 6: 2330 Parkway
Ohio, Cleveland 15: 427 Hanna Building
Texas, Houston 5: Olson Bldg., 2472 Balsover St.

Morris Machine Works, Baldwinsville, N. Y.
New York, New York 1: 50 Church St.
North Carolina, Charlotte 3: 518 E. Morehead St.
Ohio, Cleveland 14: 446 Leader Bldg.

N

Nachod & United States Signal Co., 4771 Louisville Ave., Louisville 9, Ky.

Nagle Pumps, Inc., 1249 Center Ave., Chicago Heights, Ill.

National Iron Co., Ramsey St. at 50 Ave., W, Duluth 7, Minn.

National Malleable & Steel Castings Co., Capitol Foundry Division, Phoenix, Ariz.

National Supply Co., 2 Gateway Center, Pittsburgh, Pa.
Ohio, Toledo

Naylor Pipe Co., 1243 East 92nd St., Chicago 19, Ill.
Georgia, Atlanta: 1468 Mecaslin St. N. W.
New York, New York 17: 60 E. 42nd St.
Ohio, Cleveland 14: Leader Bldg.
Pennsylvania, Philadelphia 7: Witherspoon Bldg.
Pennsylvania, Pittsburgh 22: 1304 Keenan Bldg.

Nichols Engineering, 70 Pine St., New York 6, N. Y.
California, San Francisco: 405 Montgomery St.
Indiana, Indianapolis 1: 3513 N. Hovey St.
Canada, Montreal 25: 1477 Sherbrooke St. W.

Nordberg Manufacturing Co., 3073 S. Chase Ave., Milwaukee 1, Wis.
California, San Francisco 7: 674 Harrison St.
Minnesota, Duluth: Suite 600, Alworth Bldg., 306 W. Superior St.
Missouri, St. Louis 18: 3300 S. Second St.
New York, New York 17: Lincoln Bldg., 60 E. 42nd St.
Washington, D. C. 6: 609 Barr Bldg.
Canada, Toronto 1: 909 Concourse Bldg., 100 Adelaide St., W.

Northern Blower Co., 6410 Barberton Ave., Cleveland, Ohio

P

Plymouth Locomotive Works, Div. of The Fate-Root-Heath Co., Plymouth, Ohio

R

Reich Bros. Manufacturing Co., 1439 Ash St., Terre Haute, Ind.
California, Los Angeles 21: 1201 E. 8th St.
England, London: 8 Clarges St., Mayfair.

Riblet Tramway Co., Box 7, Station A, N. 1231 Washington St., Spokane, Wash.

Rogers Bros. Corp., Albion, Pa.

Ross Screen & Feeder Co., 100 Quimby St., Westfield, N. J.
England, Surbiton, Surrey: 11 Walpole Rd., Ross Engineers, Ltd.

S

Sauerman Bros., Inc., 626 S. 28th Ave., Bellwood, Ill.

Schaffer Poidometer Co., 2828 Smallman St., Pittsburgh 22, Pa.

Simplex Wire & Cable Co., 79 Sidney St., Cambridge 39, Mass.
Arizona, Phoenix: 345 E. Pasadena St.
Georgia, Atlanta 3: 1231 Healey Bldg.
New York, New York 17: 100 Park Ave.
Ohio, Cleveland 14: Union Commerce Bldg.

Smidth & Co., F. L., 11 West 42nd St., New York 36, N. Y.

Smit & Co., Anton, 111 Eighth Ave., New York 11, N. Y.

Sprague & Henwood, Inc., 221 West Olive St., Scranton, Pa.
Colorado, Grand Junction: New Fruita Highway

Spencer Chemical Co., Dwight Bldg., Kansas City 5, Mo.

Spraying Systems Co., 3215 Randolph St., Bellwood, Ill.

Sprengnether Instrument Co., Inc., W. F., 4567 Swan Ave., St. Louis 10, Mo.

Standard Oil Company of California, Western Operations, Inc., 225 Bush St., San Francisco 20, Calif.
Arizona, Phoenix: 311 N. Central Ave.
California, Fresno: Fulton-

Fresno Bldg., Fulton & Fresno Sts.
California, Los Angeles: 605 W. Olympic Blvd.
California, Sacramento: 909—12th St.
California, San Francisco: 130 Sutter St.
Oregon, Portland: Pacific Bldg., 520 S. W. Yamhill St.
Utah, Salt Lake City: 164 South West Temple
Washington, Seattle: White-Henry-Stuart Bldg., 1318 Fourth Ave.
Washington, Spokane: Old National Bank Bldg., W. 422 Riverside Ave.
Hawaii, Honolulu: Alexander and Baldwin Bldg., 141 Merchant St.

Stardrill-Keystone Co., Beaver Falls, Pa.
New Jersey, Kearny

Stearns Magnetic Products, 635 S. 28th St., Milwaukee 46, Wis.
Illinois, Chicago 54: 7-113 Merchandise Mart Plaza
New York, New York 17: 51 E. 42d St.

Stearns-Roger Manufacturing Co., P. O. Box 5370, 660 Bannock St., Denver 17, Colo.
Texas, El Paso: 708 Electric Bldg.
Texas, Houston: 1115 City National Bank Bldg.
Utah, Salt Lake City: 40 Richards St.
Canada, Alberta, Calgary: 206-330 9th Ave. W.

Sun Shipbuilding & Dry Dock Co., Chester, Pa.

T

Texas Co., 135 E. 42nd St., New York 17, N. Y.
California, Los Angeles 15: 3350 Wilshire Blvd.
Colorado, Denver 3: 1570 Grant St.
Georgia, Atlanta: 7864 W. Peachtree St., N.W.
Illinois, Chicago 4: 332 S. Michigan Ave.
Indiana, Indianapolis 1: 354 E. Michigan St.
Louisiana, New Orleans 16: 1501 Canal St.
Massachusetts, Boston 16: 20 Providence St.
Minnesota, Minneapolis 3: 1730 Clifton Pl.
Montana, Butte: 220 N. Alaska St.
New York, Buffalo 5: P. O. Box 36
New York, New York 17: 205 E. 42nd St.
Texas, Dallas 2: 311 S. Akard St.
Texas, Houston 2: 720 San Jacinto St.
Virginia, Norfolk 2: 3300 E. Princess Anne Rd.
Washington, Seattle 1: 1511 Third Ave.

Tractomotive Corp., P. O. Box 632, County Line Rd., Deerfield, Ill.

Traylor Engineering & Mfg. Co., Allentown, Pa.
California, San Francisco 5: 605 Sharon Bldg., 55 New Montgomery St.
Illinois, Chicago 4: 1213 Fisher Bldg., 343 S. Dearborn St.
New York, New York 1: 3416 Empire State Bldg.

Treadwell, M. H., 140 Cedar St., New York 6, N. Y.
Illinois, Chicago 4: 208 S. Lasalle St.
Pennsylvania, Pittsburgh 22: 1015 Farmers Bank Bldg.

U

U. S. Steel Corp., 525 William Penn Pl., Pittsburgh 30, Pa.
Columbia-Geneva Steel Div., 120 Montgomery St., San Francisco 6, Calif.
Tennesse Coal & Iron Div. P. O. Box 599, Fairfield, Alabama
United States Steel Export Co. 30 Church St., New York 6, New York

V

Vascoloy-Ramet Corp., 800 Market St., Waukegan, Ill.
Colorado, Idaho Springs
New Jersey, Rochelle Park: Colling and Central Ave., P. O. Box 122
New Mexico, Carlsbad: 402½ South Main St., P. O. Box 348
North Carolina, Asheville: 54 Wendover Rd.
Wisconsin, Montreal: P. O. Box 488

Victaulic Company of America, P. O. Box 509, Elizabeth, N. J.
California, Los Angeles 58: 4201 District Blvd.
Georgia, Atlanta 7: 292 Candler St., N. E.
Missouri, St. Louis: 110 South Central Ave.
Pennsylvania, Monroeville: 3761 Evergreen Dr.
Texas, Odessa: P. O. Box 3444
Wyoming, Casper: 1447 West 27th St.

Victor Equipment Co., Alloy Rod & Metal Div., 13808 E. Imperial Hwy., Norwalk, Calif.
California, Fresno: 145 Van Ness Ave.
California, Los Angeles 58: 3821 Santa Fe Ave.
California, Sacramento: 1901 8th St.
Illinois, Chicago 19: J. C. Menzies & Co., 1145 E. 76th St.
Oklahoma, Wakita: Alloy Rod & Metal Div.

Vulcan Iron Works Co., 1423 Stout St., Denver, Colo.

W

Warn Manufacturing Co., Inc., 18821 Pacific Highway S., Seattle 88, Wash.

Western Machinery Company, 650 Fifth St., San Francisco 7, Calif.
Alabama, Birmingham: 113 Rockaway Road
Arizona, Phoenix: P. O. Box 6472—820 North 17th Ave.
California, Los Angeles: P. O. Box 3578-Terminal Annex—2001 South Santa Fe
California, Sacramento: 721 North "B" St.
Colorado, Denver: 2400 West 7th Ave.
Colorado, Grand Junction: P. O. Box 1498—New Fruita Highway
Illinois, Chicago: 4900 W. Madison St.
Michigan, Niles: P. O. Box 231
Minnesota, Hibbing: P. O. Box 841—2018 First Ave.
Missouri, Springfield: 1501 So. Pickwick
New York, New York 7: 50 Church St.
Ohio, Columbus: 1870 Langham Rd.
Pennsylvania, Dunmore: 1430 College St.
Utah, Salt Lake City: P. O. Box 2548—2300 So. Main St.
Washington, Spokane 11: No. 808 Division St.
Canada, Toronto, Ontario: 129 Adelaide St. W.

Western Rock Bit Mfg. Co., 552 West 7th South St., Salt Lake City 1, Utah

Wilfley and Sons, Inc. A. R., P. O. Box 2330, Denver, Colo.
New York 17, N. Y.: 122 E. 42nd St.

Winter-Weiss Co., 2201 Blake St., Denver 5, Colo.
Alabama, Birmingham: 3140 Fayette Ave.
Pennsylvania, Scranton: 221 W. Olive St.
West Virginia, Charleston 22: P. O. Box 473

White Diesel Engine Div., The White Motor Co., 1209 Russ Bldg., San Francisco 4, Calif.
California, Terminal Island: 1048 S. Seaside Ave.
Colorado, Denver 2: Suite 224 Guaranty Bank Bldg., 817-17th St.
Dist. of Columbia, Washington 6: Suite 607, Commerce Bldg. 1700 "K" St., N.W.
Florida, Clearwater: 1100 N. Osceola Ave.
Illinois, Chicago 4: Room 1142, Utility Bldg., 327 S. LaSalle St.
Louisiana, New Orleans: 1038 National Bank of Commerce Bldg., Baronne and Common St.
Minnesota, Park Rapids: Birchknoll Rd.
New York, New York 36: 547 W. 47th St.
New York, New York 17: Export Div., 415 Madison Ave.
Ohio, Springfield: 1401 Sheridan Ave.
Oklahoma, Tulsa: 318 Enterprise Bldg., 6th & Boston Sts.
Oregon, Portland 14: 237 S. E. Union Ave.
Texas, Houston 11: 5707 Navigation Blvd.
Texas, Ft. Worth 16: P. O. Box 12066, 6000 Camp Bowie Blvd.
Washington, Seattle 99: Fisherman's Terminal
Alaska, Ketchikan: 900 Water St., P. O. Box 2021
Canada, Calgary, Alberta: P. O. Box 603
Canada, Vancouver, B. C.: 1845 W. Georgia St.
Canada, Halifax, Nova Scotia: 76 Upper Water St., P. O. Box 394

Who Makes What . . .

Where Are They?

The Buying Directory Section in this Guidebook is the most comprehensive listing of manufacturers available in the industry. Product listings are based on information obtained from all known manufacturers serving the field—a company-by-company check conducted by the E&MJ editors just for this 1958 edition.

Manufacturers advertising in this issue appear in bold-face type in the Buying Directory. You'll find more helpful product information in their advertisements.

E&MJ'S MINING GUIDEBOOK AND BUYING DIRECTORY ISSUE is an annual service for all E&MJ subscribers

SEARCHLIGHT ADVERTISERS' INDEX
1958 E&MJ MINING GUIDEBOOK & BUYING DIRECTORY

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8 Cable
9 Cars, Gondola
10 Cars, Hopper
11 Cars, Mine
12 Centrifuges
13 Classifiers
14 Communication Equipment (Telephones, Etc.)
15 Compressors
16 Concentrating Tables
17 Cranes
18 Crushers
19 Diesel Engines
20 Drills and Sharpener Equipment and Parts
21 Dryers and Kilns
22 Fans and Blowers
23 Feeders
24 Filters
25 Flotation Machines and Equipment
26 Generating Equipment
27 Grinding Mills
28 Hoists
29 Hose, Rubber and Belting
30 Instrument Service and Rental
31 Loaders
32 Locomotives
33 Mining Transits & Survey Equipment
34 Motors
35 Muckers
36 Piling
37 Pulverizers
38 Pumps
39 Rail
40 Rebuilding
41 Samplers
42 Screens
43 Separators
44 Shovels & Draglines
45 Slushers
46 Thickeners
47 Track Equipment
48 Transformers
49 Trucks, All Types
50 Wire

The numbers after the advertiser's name, indicate the products or services offered by the advertiser.

ADVERTISER	PAGE NO.	KEY NUMBERS TO PRODUCTS OR SERVICES *See Classifications Above*
Adams Aircraft Sales, Inc., Jack	258,260	1-7
Buff Industries, Inc.	258	30-33
Chapin Cylinder Head Co.	258	40
Fish Co., Charles	259	2-18-21-27-28-34
Foster, L. B.	258	36-39-47
Frazier-Davis Construction Co.	260	11-28-32-35
General Machinery & Equipment Co., Inc.	260	19-22-26-34
Harding, Leo A.	258	28-34
Heat & Power Co., Inc.	260	2-4-5-12-13-15-18-21-24-26-27-37-42-43-48
Heineken, Inc., W. P.	259	2-3-18-21
Hyman-Michaels Company	258	6-9-10-11-17-28-32-39-47
Lefton Industrial Corp.	259	22-34
Lubrecht Construction Equipment, William	258	17-49
Machinery Center, Inc.	259	2-3-11-13-14-15-16-17-18-20-21-22-23-24-25 27-28-29-31-32-34-35-37-39-41-42-45-46-47-48
Midwest Steel Corp.	259	39-47
Missouri Car & Locomotive Co.	260	17-32
National Electric Service Co.	258	34-48
National Surplus Sales Co.	259	14-15-28-38
O'Neill, A. J.	258	2-3-11-13-15-17-18-21-23-24-27-28-31-32-34-37 43-44
Perry Equipment Corp.	258	2-21
Telephone Engineering Co.	260	14
Tractor & Equipment Co.	258	3-6-17-49
Universal Wire & Cable Co.	258	8-50

COMPRESSORS

Ingersoll Rand, 1055 CFM, XRE, 440 volts.
Ingersoll Rand, 1575 CFM, PRE2, 2200 volts.
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Ingersoll Rand, 3864 CFM, PRE2, 2200 volts.
Ingersoll Rand, 4150 CFM, PRE2, 2200 volts.

ELECTRIC MINE HOISTS FOR SHAFTS

1250 H.P., double drum, 10' dia., 10' face, 1⅜" rope.
900 H.P., double drum, 14' dia., 7' face, 1¾" rope.
600 H.P., double drum, 10' dia., 10' face, 1⅜" rope.
600 H.P., double drum, 8' dia., 4' face, 1¼" rope.
500 H.P., double drum, 6' dia., 3'6" face, 1" rope.
500 H.P., double drum, 6' dia., 4' face, 1¼" rope.
400 H.P., double drum, 6' dia., 5' face, 1" rope.
400 H.P., double drum, 7' dia., 4'6" face, 1⅜" rope.
300 H.P., double drum, 5' dia., 4' face, 1" rope.
250 H.P., double drum, 5' dia., 3' face, 1" rope.
200 H.P., double drum, 5' dia., 3'6" face, 1" rope.
150 H.P., double drum, 4' dia., 3' face, 1" rope.
75 H.P., double drum, 3' dia., 2' face, 1" rope.

900 H.P., single drum, 10' dia., 6'6" face, 1¾" rope.
800 H.P., single drum, 7' dia., 6' face, 1⅛" rope.
700 H.P., single drum, 10' dia., 10' face, 1½" rope.
700 H.P., single drum, 7'8" dia., 6' face, 1⅜" rope.
500 H.P., single drum, 10' dia., 7' face, 1¼" rope.
500 H.P., single drum, 6' dia., 6' face, 1⅛" rope.
400 H.P., single drum, 7' dia., 7' face, 1⅛" rope.
350 H.P., single drum, 8' dia., 5' face, 1½" rope.
300 H.P., single drum, 6' dia., 4' face, 1⅛" rope.
200 H.P., single drum, 5' dia., 4'6" face, 1" rope.
200 H.P., single drum, 6'6" dia., 7'8" face, 1¼" rope.
150 H.P., single drum, 7' dia., 5'4" face, 1⅜" rope.
100 H.P., single drum, 4' dia., 3'6" face, 1" rope.

All the above complete with motors, Lilly control, post brakes, etc. Complete specifications and drawings available.

CAR PULLER WINCH

30 H.P. triple reduction, 46,000# single line pull, 220/440 volt.

SHOVEL

Bucyrus Erie 2½ yd. electric, model 54-B, with or without dragline equipment, 2200 volt.

CLASSIFIERS

4—Wemco and 2—Akins 78" duplex spiral with tanks 36'6", all complete, new condition.

ROTARY KILNS & DRYERS

4½' x 40 ft., 5' x 50' ft. and 8' x 40 ft. Rotary Kilns, all modern, gas fired, complete with all equipment, including instruments and controls. One 9 ft. x 120 ft., two 8 ft. x 125 ft. Two Ruggles Coles Dryers class XA18, 104" dia. x 65 ft., new condition. One Ruggles Coles class XH12, 80" x 60 ft., new 1955. One Ruggles Coles class XA, 5 ft. x 30 ft. One 6 ft. x 50 ft. rotary Steam dryer. One Kiln 10' dia. x 210 ft., ¾" plate.

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10 x 15", 10 x 20", 12 x 24", 15 x 36", 24 x 36", 25 x 40", 30 x 42" and 40 x 42". One 18 x 30" and one 24 x 72" sectionalized for underground use.

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A. J. O'NEILL

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Lansdowne, Pa.
Phila. Phones: MAdison 3-8300—3-8301

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AT ATTRACTIVE PRICES

1 Ohio 35 ton Diesel Locomotive Crane
1 Ohio 35 ton Gas Locomotive Crane
1 30 ton Plymouth diesel Locomotive
1 65 ton Whitcomb diesel electric Locomotive
3 20 cu. yd. automatic air operated side Dump Cars
1 30 cu. yd. automatic air operated side Dump Car
20 All steel drop bottom Gondola Cars
50 70 ton capacity all steel quadruple Hopper Cars
50 60 ton cap. all steel twin Hopper Cars

All equipment Standard Gauge—In excellent condition

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$78,600 Executive Lockheed Lodestar

Serial No. 2190 N74659, total time 3259 hours, formerly owned by Eastman Oil Well Survey Company, executive plush interior, immaculate, Spartan majored engines with only 222 hours, one extra zero time engine Spartan overhauled, beautifully equipped with excellent radios, new Remmert-Werner inspection with new CAA periodic just completed, recent tank resealed, gas tanks recently resealed, a beautiful executive Lodestar, ready for immediate delivery, will trade.

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Box 5445, Memphis 16, Tennessee
Phone EX 1-4436

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POplar 3-3505

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80 30 H.P. Intermittent—25 H.P. Continuous Squirrel Cage Motors—Drip Proof BB 3/60/220/440—1750 RPM—Frame 324-U w/slide basis

National Electric Service Co.
321 Lombard St. PHONE
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EUCLID TRUCKS—Rear and bottom Dumps.
SHOVELS, DRAGLINES—All sizes, makes. Crawler and walking type.
9 YD. ELEC. DRAGLINE
1208 and 170B Bucyrus-Erie Electric Shovels.
WELL DRILLS—Rotary and Churn type.
TRUCK CRANES—CRAWLER CRANES.
DOZERS—FRONT END LOADERS and GRADERS.
SCRAPERS—All makes and sizes.
LOWBED TRAILERS.
"Other Equipment available not listed above".

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Construction Equipment
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GLadstone 5-4041 - 5-0253

Cylinder Head Rebuilding
Cracks welded, Machined.
Pressure & Magnetic Testing
Gasoline & Diesel

Chapin Cylinder Head Co.
Chapin, Ill. (Morgan County) Phone #3.

USED MINING MACHINERY

Hoists, Pumps, Compressors, Loaders, Locomotives, Generators, Motors AC & DC

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DEPENDABLE USED MACHINES

Special: American 25 ton truck crane 375 BT, powered by gas engine, w/75' boom.

H&B 6" pump	Bay City 25 dragline	Pioneer 30x12 conveyor
Schield Bantam	Galion Jr. Patrol Grader	Pioneer 30x14 conveyor
2 yd. Dumpcrete	Pioneer 3x10 d.d. screen	Pioneer 30x20 conveyor
Agricat bulldozer	Harris Power Horse Hi-Lift	30x38 portable conveyor
Terratrac Model 400	Universal 3½x8' d.d. screen	4-wheel Bay City 12 t. trailer

This equipment rebuilt in our modern plant by expert mechanics. Come see it!
10004 Southwest Highway TRACTOR & EQUIPMENT CO. Oak Lawn, Ill.

WORLD'S LARGEST INVENTORY USED MILL AND MINING MACHINERY

Here's a typical list of equipment available . . .

CLASSIFIERS
1—45" x 17' Akins Spiral
1—48" x 17' Akins Spiral
1—48" x 38'6" Wemco Spiral
1—36" x 19'3" Wemco Spiral
1—60" x 20'9" Wemco Spiral
3—16" x 28' Dorr Oliver Rake

COND.TIONERS
1—5' x 6' Wemco, Steel Tank
1—5' x 5' Denver Equipment
1—6' x 6' Gallagher, Steel Tank

CRUSHERS
1—2' Symons Shorthead Cone, 30 HP
1—2' Symons Std. Cone, 30 HP
1—3' Symons Shorthead Cone
1—5½' Symons Std. Cone
1—322 Type R Allis-Chalmers Reduction
1—4" x 6" MASSCO Jaw Crusher
1—8 x 10 Denver Jaw, Roller Bearing
1—10 x 21 Telsmith Jaw, R.B.
1—15 x 24 Traylor Jaw
1—24" x 36" Traylor Jaw
2—36" x 48" Birdsboro Buchanan Jaw, 150 HP Motor
2—60" x 24" Traylor Crushing Rolls

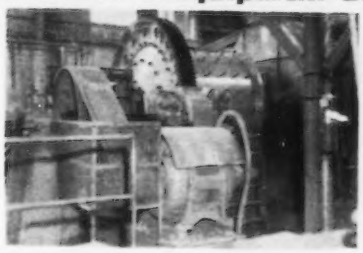
FEEDERS, ORE
1—54" x 16' Stephens-Adamson Apron Type
1—42" x 96" Apron Type, 7½ HP Gearmotor
1—36" x 72" Jeffrey Grizzly, 440 Volt
2—24" x 8' Denver Adjustable Stroke
1—24" x 5' Denver Adjustable Stroke

FEEDERS, REAGENT
8—Clarkson, Model E, Stainless
1—DECO ⌀12 Simplex
1—Denver 12" Cone, Dry Type
2—Zeigler Type, 2.5 cu. ft. motorized

FILTERS
2—3' x 4' Oliver Drum, Complete
1—4' x 1-leaf Eimco Disc Type
1—6' x 8' Oliver Drum Stainless Steel
1—6' 6-leaf Oliver Disc Type
1—6' 3-leaf Eimco Disc Type
1—6' 2-leaf Eimco Disc Type
1—4' 4-leaf Denver Disc Type

FLOTATION MACHINES
1—3-cell ⌀18 Denver Sub-A, 28" x 28"
2—6-cell ⌀18 Denver Sub-A, 28" x 28"
1—6-cell ⌀18 Sp. Denver Sub-A, 32" x 32"
1—4-cell 18 Sp. Denver Sub-A, 32" x 32"
1—6-cell No. 24 Denver Sub-A, 43" x 43"
1—6 cell No. 30 Denver Sub-A, 56" x 56"
2—2-cell Size 44" Fagergren
4—3-cell Size 44" Fagergren
2—8-cell Size 56" x 56" Fagergren

JIGS
3—12" x 18" Denver Duplex
1—16" x 24" Denver Simplex
1—24" x 36" Denver Simplex
1—24" x 36 Denver Duplex
1—26" x 26" Pan American Duplex
2—42" x 42" Pan American Duplex
1—12" x 12" Pan American Simplex



MILLS, ROD AND BALL
14—8' x 6' Marcy Type Ball
1—6' x 8' Allis-Chalmers Ball
2—6' x 9' Allis-Chalmers Ball
6—6' x 12' Allis-Chalmers Ball
1—64½ Marcy Ball
1—6' x 4' Denver Ball
1—7' x 6' Allis-Chalmers Ball
1—5' x 5' Eimco Ball
1—3' x 8' Denver Rod Mill
1—4' x 8' Traylor Rod Mill
1—6' x 12' Marcy Rod Mill

PUMPS, SAND
6—8" Willey, Type C
14—4" Wemco, Reconditioned
2—3" Wemco overhead motors
2—2" Wemco overhead motors
5—2" Willey overhead motors
9—1½" Wemco overhead motors
2—4" Dorr Simplex Diaphragm
1—2" Dorr Duplex Diaphragm
1—4" Dorr Duplex Diaphragm
2—½" DECO Suction Pressure
1—4" DECO Suction Pressure

SAMPLES
3—20" Geary-Jennings Automatic
1—20" GECO, Automatic
1—3' dia. Denver Synder, moterized
1—21" Denver, automatic

SCREENS
1—3 x 8 Allis-Chalmers Ripl8o, 1 deck
14—4 x 5 Tyler Hummer, 1 deck
4—4 x 8 Tyler Niagara, 1 deck
1—3 x 10 Overstrom, 3 deck
1—3 x 6 Symons Rod Deck
1—3 x 7 Link Belt, 1 deck

TABLES
2—13-S Willey Concentrating
106—Diester Concentrating
5—Model 6S Willey Concentrating

THICKENERS
1—18 x 7 Denver, Lowhead Steel
2—20' x 8' Wemco, Lowhead, Steel tank
1—24' x 10' Denver Spiral Rake

MOBIL MILL
1—WKE Portable Mobil Mill, Model 3M Complete

WEIGHTOMETERS
16—Model E Merrick 20" Belt

ASSAY EQUIPMENT
2—Ainsworth Analytical Balances
1—12" x 24" Denver Ball-Rod Mill
2—2¼ x 3½ Denver Lab Jaw Crusher
1—5" x 6" Denver Lab Jaw Crusher
1—16" x 10" Denver Labor Crushing Rolls
5—12" Gallgher Pressure Filters
2—2000 gm Fagergren Lab. Flot. Cells
1—DFC Muffle Furnace
1—9½ K McCool Pulverizer
2—Denver Pulp Density Scale, 2300 gpm
1—Tyler Rotap Sieve Shaker

BLOWERS
2—TMB Coppus Ventair, 15 HP
5—TMT Coppus Ventair, 10 HP
2—Jay Series 1000 Axivane 5 HP
2—SP-125 Coppus Vano, air driven

BUCKETS, SCRAPER
24—36" Pacific
1—60" Pacific, Type 2 C
150—6" Joy Scraper Sheaves

CAP LAMPS
165—MSA, Type R, Edison w charger

CARS, MINE ORE
6—20 cu. ft. Card Rocker Dump, 24" Ga.
12—36 cu. ft. Card Rocker Dump, 24" Ga.
40—32 cu. ft. Ajax Type, Side Dump, 18" Ga.
52—18½ cu. ft., Ogden Iron Works, 18" Ga.
12—5-ton Card, Granby Type, 24" Ga.

DRILLS, ROCK
1—Many-Jackhammers, stopers, air legs, wagondrills, jumbos

COMPRESSOR
1—450 CFM CP, 100 HP
1—2300 CFM IR PRE-2 500 HP
1—1500 CFM Worthington, 300 HP
1—1100 CFM Joy WN-114, 200 HP

DIAMOND DRILL
2—HS-15 Sullivan EX Size
1—Longyear 24 Gas Driven
1—Joy Model 12B Gas Driven

HOIST, MINE SHAFT
1—800 HP Nordberg, Double Drum
1—900 HP Allis-Chalmers, Double Drum
1—375 HP W-S-M, Double Drum
1—600 HP Vulcan, Double Drum
1—150 HP Vulcan, Double Drum
1—600 HP Nordberg, Double Drum
1—700 HP W-S-M, Single Drum
1—300 HP W-S-M, Single Drum
1—150 HP Vulcan Denver, Single Drum
1—100 HP Coeur d'Alene, Single Drum
3—75 HP Vulcan, Single Drum

HOISTS, TUGGERS AND SLUSHERS
1—50MNM4C I-R 3-drum, 440 Volt
6—50 NM4D I-R, 2-drum, 440 Volt
5—HNN15 I-R, 2-drum, air
4—A3NNDH I-R, 2-drum, Air
5—S211 Joy, 2-drum, 5 HP, 440 Volt
1—A2F-211 Joy, 2-drum, 15 HP, 440 Volt
27—1JNNIG I-R, 440 Volt
1—HEE Gardner-Denver, 2-drum, air
3—E-113 Sullivan Turbinaire
2—E-111 Joy Tugger, Air
1—EU I-R Tugger, Air
3—D6U I-R Tugger, Air

LOADER, MUCKING MACHINE
3—21 Eimco, 18"-24" Ga.
3—12-B Eimco, 18"-24" Ga.
7—GD9 Gardner-Denver, 18"-24" Ga.
1—105 Eimco Crawler-Loader, 1½ yd.

WE ALSO HAVE COMPLETE MILLS, FLOTATION PLANTS, 50-TONS TO 1500-TONS AVAILABLE FOR SALE.

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5—1½ ton Mancha "Little Trammers" Battery 18"-24" Ga.
5—1½ Ton Atlas "Type J" Battery, 18" Gauge, complete
4—2½ ton Greensburg Battery, 24" Ga. complete
1—3-ton Jeffrey Battery, 18" Ga. complete
1—4-ton Mancha Battery, 24"-42" Ga.
1—7-ton Plymouth Diesel, 18" Ga. with scrubber
1—25-ton G.E. Diesel, Std. ga. Cummins Engine

YOU CAN COUNT ON MACHINERY CENTER to have
Machinery for all mining & milling needs
REBUILT GUARANTEED USED
**** CONTACT US FOR YOUR SURPLUS EQUIPMENT ****

MACHINERY CENTER, INC.

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HUnter 4-7601

Portable Pumper Johnson Model P-500
For sump, irrigation or fire fighting . . . This light weight portable U.S. Navy pumper has a rated delivery of 500 GPM at 100 PSI. Powered by a Johnson 4 cyl. opposed type, 2 cy. engine. With a 4" inlet and two 2½" outlets, both threaded for fire hose couplers. A hand priming pump is mounted in the tubular carrying frame. Shipping weight 256 lbs. Dimensions 21" x 26" x 27".
Two pumps connected in series will develop 200# pressure. $345 each F.O.B. Kansas City 2 for $650. Write For Brochure

National Surplus Sales
1800-14 Charlotte, Kansas City 8, Mo.

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6'5" x 100'

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1—24" x 36", 18" x 36", 12" x 24" Jaw Crusher ⌀332 A-C Hydro-Cone
2—42" x 16" Allis-Chalmers Crushing Rolls
36" x 16" rebuilt Sturtevant Rolls
2—24" x 14" Rogers Iron Works Rolls
1—24" x 12" Farrell Bacon Crushing Rolls
28" Telesmith Intercom Crusher
—6", 10", 20" McCully Super Gyratory Crushers No. 3 up to No. 12 Gyratory Crushers

BALL & TUBE MILLS:
2—5½' x 20' & 6' x 22' & 47' x 24' Tube Mills

W. P. HEINEKEN, INC.
50 Broad St., WH 4-4236 NEW YORK 4, N. Y.

FOR SALE

- **CRUSHERS:**
  30"x42" KVS Blake type jaw 100 HP
  38½ KVS Gyratory with 75HP, late type
  37½ KVS Gyratory with 75HP, late type
  25½ KVS Gyratory with 40HP, late type
- **GRINDING MILLS:**
  7'x36" HARDINGE CONICAL MILL, 100HP, Air Swept, late type
  7'x18' PATTERSON TUBE MILL, 2 compartments, 400HP, NEW 1955
- **CONVEYORS:**
  400'—36" wide complete with motor, drive & belt
  500'—36" wide complete with motor, drive & belt
  1200'—36" wide complete with motor, drive & belt

CHARLES V. FISH CO.
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HE 5-4701

NEW RAIL
20# — 30# — 40#
IN STOCK
LEFTON INDUSTRIAL CORP.
GENERAL OFFICE: 212 Victor St.
St. Louis 4, Mo.

$64,700
Lockheed Lodestar

Serial No. 2039, N46F, has brand new Remmert-Werner CAA periodic, has been flown 285 hours, aircraft completely re-wired and converted to 24 volt system, one piece windshield, prop. and windshield alcohol, plumbed for de-icer boots, dual Collins 360 channel 51R Omni's, dual instrumentation, dual Bendix ADF's, Collins 17L3 transmitter, Lear LVTR-36 standby transceiver, Bendix MN53A 3 light marker beacon receiver, dual R89B 10 channel glide slope receivers, useful load 5405 lbs, basic weight 13,095 lbs. Will trade.

Jack Adams Aircraft Sales, Inc.
Box 5446, Memphis 16, Tennessee
Phone EX 1-4436

LOCOMOTIVES FOR SALE
2—70 Ton Whitcomb Diesel Elect.
1—30 Ton Plymouth 36" gauge
R.R. Cars, Cranes & Locomotives Bought and Sold
Missouri Car & Locomotive Co.
8465 Halls Ferry Road
St. Louis 15, Missouri

HEAT & POWER Co., Inc.
MINING EQUIPMENT DIVISION

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310 THOMPSON BLDG. TULSA 3, OKLAHOMA Diamond 3-4890

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- BALL & ROD MILLS
- BOILERS
- BRIQUETTING EQUIPMENT
- CENTRIFUGALS
- CLASSIFIERS & THICKENERS
- COMPRESSORS
- CRUSHERS
- DRYERS & KILNS
- FILTERS
- GENERATORS—DIESEL & TURBINE
- GRINDERS & PULVERIZERS
- SCREENS & SEPARATORS
- TRANSFORMERS

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Gentlemen:
Please add my name to your company's mailing list:

Name ..... Title .....
Company Name .....
Address .....
City ..... State .....
I am interested in the following:
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Heat & Power Co., Inc.
60 E. 42nd St., New York 17, N.Y.

FOR SALE

1—Single Drum Hoist Ottumwa 150 H.P.—2300 volt—60 cycle—3 phase
1—55' Headframe for 2 comp. shaft.
3—21—Eimco Tunnel Muckers—24" gauge
20—2½ cy. Watt Muck cars, side dump 24" gauge with "Can't-Miss" Couplers
5500'—of 18" Naylor Fanline with Couplings
1—Jeffrey Pan Feeder
4—Canton Car transfers, for 24" gauge track

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1319 Macklind Ave. ST. Louis 10, Mo.
Ph. ST. 1-1950

U. S. Army Telephones EE-8 fully reconditioned. Suitable for intercommunication between 2 or more points. $35.00 for 2 telephones, including 100 ft. of wire and batteries. Additional wire 1¢ per ft. or $25.00 per mile.

Write for free list on telephones. ALL shipments F.O.B. Simpson, Pa.

TELEPHONE ENGINEERING CO.
DEPT. EMJ-6 SIMPSON, PA.

WE SELL ENGINES . . .
50 HP to 2000 HP

1—1225 HP F & M Mod. D-33, w/generator
1—1050 HP F & M Mod. D-33, w/generator
1—900 HP Alco Diesel, 720 RPM
1—F & M 2 million BTU Jacketed Water Cooler
3—30 x 18 Condensers, 280 1" Tubes
2—34 x 15 Condensers, 356 1" Tubes
1—150,000 CFM Buffalo Load Limit Fan
1—8 x 10 Ball Mill
Also 4100 ft. of 42" Troughing Belt Conveyor.
Also carry Electric Motors, Generators, etc.
GENERAL MACHINERY & EQUIPMENT CO., Inc.
801-15 Woodland, Kansas City 6, Mo.
PH-Victor 2-0018

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If you are in need of good used mining equipment . . . check the used equipment index on page 257 and the "SEARCHLIGHT" advertisements in this issue.

If the product you're looking for is not listed under any of the 50 categories . . . fill out the "SEARCHLIGHT" Equipment Spotting Service listing to the right . . . and mail it to us. Your requirements will be brought promptly to the attention of all the "SEARCHLIGHT" advertisers in this issue.

SEARCHLIGHT Equipment Spotting Service

This service is aimed at helping you, the reader of "SEARCHLIGHT", to locate Surplus New and Used mining equipment ***not currently advertised.*** (This service is for USER-BUYERS only) No charge or obligation.

How to use: Check the dealer ads to see if what you want is not currently advertised. If not, send us the specifications of the equipment wanted on the coupon below, or on your own company letterhead to:

Searchlight Equipment Spotting Service
c/o ENGINEERING & MINING JOURNAL
330 W. 42nd St.
N. Y. 36, N. Y.

Your requirements will be brought promptly to the attention of the equipment dealers advertising in this section. You will receive replies directly from them.

Searchlight Equipment Spotting Service
c/o ENGINEERING & MINING JOURNAL
330 W. 42nd St, N.Y. 36, N.Y.

Please help us locate the following equipment:

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NAME ..... TITLE .....
COMPANY .....
STREET .....
CITY ..... ZONE ..... STATE .....

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Professional Services

ASSAYING
CONSULTING
PROSPECTING
ORE TESTING

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ADVERTISERS IN THIS ISSUE

Aero Service Corp. 140
Ainsworth & Sons, Inc., Wm. 168
Allen-Sherman-Hoff Pump Co. ..... Second Cover
American Brattice Cloth Corp. 194
American Cyanamid Co. Insert between pp. 116–119
American Cyanamid Co. (Explosives Dept.) Insert between pp. 116–119
American Mine Door Co. 167
American Smelting & Refining Co. 153
Anaconda Wire & Cable Co. 14, 130
Asea Electric, Inc. 124
Associated Metals & Minerals Corp. 188
Austin-Western Works, Construction Equipment Div., Baldwin-Lima-Hamilton Corp. .. 180

Babcock & Wilcox Co., Boiler Div. ... 8, 144–145
Baker & Adamson Products, General Chemical Div., Allied Chemical Corp. 208
Bin-Dicator Co. 206
Boyles Bros. Drilling Co. 134
Boyles Bros. Drilling Co., Ltd. 131
Buell Engineering Co. 193
Brunner & Lay, Inc. 198
Burtonite Co. 206

Card Iron Works Co., C. S. 166
Carpco Mfg. Co. ..... Third Cover
Cheatham Electric Switching Device Co. 200
Christensen Diamond Products 12–13
Coates Steel Products Co. 163
Colorado Fuel & Iron Corp. 18
Connellsville Mfg. & Mine Supply Co. 183
Coppus Engineering Corp. 15
Crucible Steel Co. of America 181

Denver Equipment Co. 161
Diamond Drill Contracting Co. 194
Diamond Tool Research Co., Inc. 196
Diesel Energy Corp. 202
Ducon Co. 197

Eimco Corp. 184–185
Elektrokemisk, A. S. 204
Ensign-Bickford Co. 2
Equipment Engineers, Inc. 125
Exide Industrial Div., Electric Storage Battery Co. 164

Falk Corp. 119
Fate-Root-Heath Co. 209

Gardner-Denver Co. 148–149
Godoy & Co., Inc., E. A. 160
Goodrich Aviation Products, B. F., a Div. of B. F. Goodrich Co. 120
Gould & Co., Gordon I. 210

Hammond Co., J. V. 210
Harbison-Walker Refractories Co. 158–159
Hardinge Co., Inc. 146–147
Harnischfeger Corp. 121
Hawthorne Inc., Herb J. 205
Hercules Motors Corp. 213
Hercules Powder Co. 154
Hewitt-Robins 136–137
Hoffman Bros. Drilling Co., Inc. 208
Humphreys Engineering Co. 192

Industrial Physics & Electronics Co. 198
Ingersoll-Rand Co. 1
International Bartering Co. 196
International Minerals & Metals Corp. 210
Iowa Mfg. Co. 129
Isbell Construction Co. 190

KW-Dart Truck Co. 211
Kennametal, Inc. 189
Kern Instruments, Inc. 207

LeTourneau-Westinghouse Co. 141, 143
Linatex Corp. of America 182
Link-Belt Co. 151
Logan Engineering Co. 172

Machinery Center, Inc. 215
Mack Trucks, Inc. 203
Magor Car Corp. 174–175
Mayo Tunnel & Mine Equipment Co. 206
Merrick Scale Mfg. Co. 214
Mine & Smelter Supply Co. 142
Mine Safety Appliances Co. 178–179
Mobile Drilling, Inc. .. Insert between pp. 18–21
Monsanto Chemical Co. 165
Morris Machine Works 199

Nachod & United States Signal Co., Inc. 200
Nagle Pumps, Inc. 188
National Iron Co. 191
National Malleable & Steel Castings Co. 171
National Supply Co., Industrial Products Div. 176
Naylor Pipe Co. 128
Nichols Engineering & Research Corp. 173
Nordberg Mfg. Co. 16–17
Northern Blower Co. 186

Reich Bros. Mfg. Co. ..... Fourth Cover
Riblet Tramway Co. 186
Rogers Bros. 214
Ross Screen & Feeder Co. 126

Sauerman Bros., Inc. 170
Schaffer Poidometer Co. 212
Searchlight Section 257–261
Simplex Wire & Cable Co. 122–123
Smidth & Co., F. L. 126
Smit & Co., Inc., Anton 212
Spencer Chemical Co. 187
Sprague & Henwood, Inc. Insert between pp. 8–11
Spraying Systems Co. 212
Sprengnether Instrument Co., Inc., W. F. 160
Standard Oil Co. of California 155
Stardrill-Keystone Co. 200
Stearns Magnetic Products 201
Stearns-Roger Mfg. Co. 169
Sun Ship Building & Drydock Co. 127

Texas Co. 4–5
Tractomotive Corp. 157
Traylor Engineering & Mfg. Co. 138–139
Treadwell Co., Inc., M. H. 132–133

United States Steel Corp. 135

Vascoloy-Ramet Corp. 152
Victaulic Co. of America 156
Victor Equipment Co. (Alloy Rod & Metal Div.) 195
Vulcan Iron Works Co. 177

Warn Mfg. Co. 204
Western Machinery Co. 11
Western Rock Bit Mfg. Co. 168
White Diesel Engine Div., White Motor Co. 150
Wilfley & Sons Co., A. R. 216
Winter-Weiss Co. 190

PROFESSIONAL SERVICES 261

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.

EQUIPMENT (Used or Surplus New) For Sale 258–260

ADVERTISERS INDEX 257

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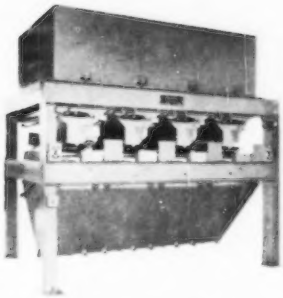

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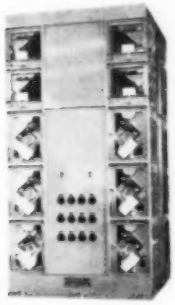

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